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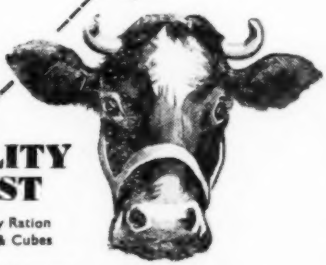

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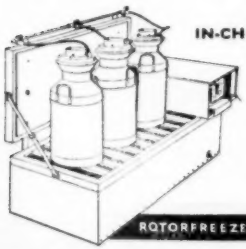

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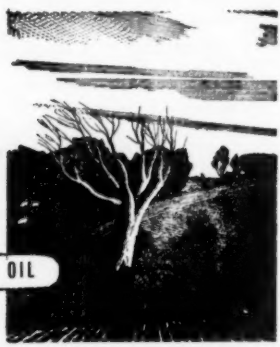

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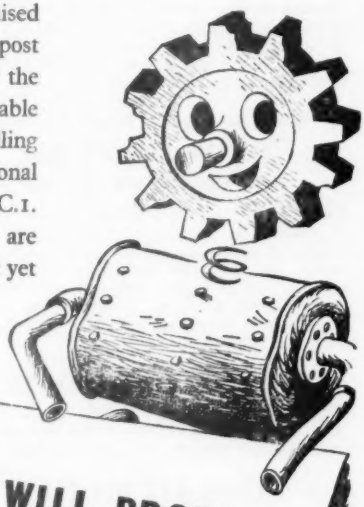

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VOL. LIX No. 6 SEPTEMBER 1952

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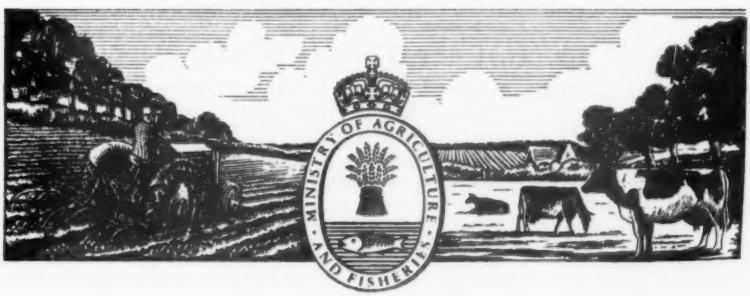

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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THE RELATIVE VALUES OF ALTERNATIVE LIMING MATERIALS

E. M. CROWTHER, D.Sc., F.R.I.C.
Rothamsted Experimental Station, Harpenden, Herts
and
T. W. WALKER, B.Sc., PH.D.
formerly National Agricultural Advisory Service, West Midland Province

The relative neutralizing power of various kinds of liming materials may be ascertained in the laboratory, but their practical value can be judged only from results of field trials such as those carried out from 1944 by the Advisory Chemists.

LIMING materials have been used in steadily increasing quantities during the last fifteen years, but large areas still suffer from soil acidity or lack of lime. Since 1937, a considerable fraction of the cost of liming materials has been met by direct subsidy, and there has also been a marked change in the relative proportions of the two main classes of material—burnt lime and ground limestone—used on British farms. For many hundreds of years the soft Cretaceous limestone known as "Chalk" has been used in the south and east of England, in occasional heavy dressings. The material is soft enough to break down under the action of frost and becomes well incorporated with the soil in a few years. Most of the other limestones are too hard to be used in this way and, long ago, it was found better to burn them down to lump quicklime which could be slaked to a powder suitable for distribution. In the last dozen years or so, many new limestone grinding plants have been installed to crush these hard limestones, and a shortage of labour and fuel have made it desirable to reduce the amount of burnt lime used on the land.

Some farmers have, however, failed to appreciate the advantages of ground limestone, either because they were unfamiliar with it or because they expected to obtain some special benefit from the most caustic form. There are good theoretical grounds for measuring the relative values of alternative liming materials in terms of their "neutralizing values". The main function of liming materials is to neutralize acid substances in the soil, and their values for this purpose can be measured in the laboratory by determining how much acid they neutralize. The results of the tests are most conveniently expressed as parts of calcium oxide per hundred parts of material. On this basis, 100 parts pure calcium carbonate are equivalent to 56 parts pure calcium oxide. In general, ground limestone has about half the neutralizing value of ground burnt lime, provided both are equally well incorporated with the soil. The burnt lime may be expected to react with the soil more quickly and should therefore be preferred in the case of an emergency—for example, when the immediate need for lime is realized only

shortly before a sensitive crop has to be sown. There are, however, a number of circumstances in which ground limestone may be better than an equivalent quantity of quicklime. Lump lime is troublesome to slake and spread, and the final distribution is often very patchy. Although ground burnt lime may be spread more evenly, it is apt to run together and set after it is exposed to rain on the land. The particles of ground limestone do not cake in this way and may therefore become incorporated into the land more uniformly, and act more efficiently than the equivalent amount of burnt lime.

As there were many points about the practical use of alternative liming materials which could not be settled on purely theoretical grounds, the Advisory Chemists started a series of field trials in different parts of the country in 1944, the programme of the experiments being drawn up by a committee under the chairmanship of the late Professor G. W. Robinson. The results of these experiments are summarized in this article.

Field Experiments The main object of the experiments was to compare the effects of alternative liming materials on crop yields. Whenever possible, one or more of the materials was used at two different rates of application to indicate the sensitivity of the test and the best rate of application. Burnt limes and ground limestones of different kinds were tested, and comparisons were made between limestones ground to different degrees of fineness. The design of the experiments, the amount of replication and the choice of materials varied from district to district, according to the facilities available and special local interests. In a brief summary of the main results it is not possible to present all the individual results for each type of experiment. The statements are therefore restricted to results for the main classes of material, comparable figures being selected from all experiments in which the same set of materials was included.

As soils differ markedly in the amounts of liming material needed to effect a substantial reduction in soil acidity, the standard rate for each centre was determined by analysing the soil by a conventional method (generally the Hutchinson-McLennan "lime-requirement" method). In most experiments a standard material was applied at half-standard and standard rates and the other materials at the standard rate, the equivalents being determined in terms of neutralizing value. Plots without liming material were also included.

To provide the best opportunity for finding differences between rates and forms of liming materials, most of the experiments were put down on very acid soils, generally light in texture, and, wherever possible, acid-sensitive crops, such as sugar beet, mangolds and barley, were chosen for the first crop. At a few special centres these crops could be grown on the experimental site more frequently than in a normal rotation, but the majority of the experiments were on commercial farms and had therefore to fall in with the normal cropping rotation of the farm. This meant that acid-sensitive crops were soon followed by less sensitive ones, which gave little opportunity for revealing differences in the residual effects of the various kinds of liming material. Many of the fields were sown down to leys in the second or third season after liming ; others grew swedes, turnips, wheat and oats. With grass and cereals it was often impossible to obtain yields by weighing the crops; visual estimates were therefore made on the individual plots. In order to extend the general averages to cover as many centres as possible, the results are given, first, as means of recorded yields, then for "other crops," and for the average of all crops as means of relative yields. The relative yield figures were obtained by expressing the yields or estimates of yields as percentages

of the mean values for the treatments listed, and then averaging the percentage values in the individual experiments.

Ground Limestone Fractions To obtain an extreme test on the effects of particle size, special batches of ground Carboniferous limestone were separated between sieves. These fractions were not, of course, commercial materials. The mechanical analyses given in Table 1 show that the large-scale sieving was far from perfect. Nevertheless, these fractions represented an extreme range in degrees of fineness, the percentages passing the 100-mesh sieve being 6, 27 and 95 per cent respectively. The predominant fractions were 20–40 mesh, 40–100 mesh and through 100 mesh.

Table 1

Mechanical Analyses of Ground Carboniferous Limestone Fractions

	ACTUAL PERCENTAGES			
Fraction	Over 20 mesh	20–40 mesh	40–100 mesh	Through 100 mesh
Coarse	3	88	3	6
Medium	0	7	66	27
Fine	0	1	4	95

Each fraction was tested in the field experiments at the standard rate with ground burnt lime at half-standard and standard rates.

Owing to variations in rotations, the various crops did not occur at fixed periods after liming. Sugar beet was generally taken immediately after liming, mangolds and the " other crops " in the second season, barley in the second or third season, and hay in the third or fourth season after liming. The relative effects of the liming materials in successive years thus tend to be measured in different crops, but the general sequence of cropping is similar to what would occur on many farms. In two of the experiments, sugar beet was taken as the first crop on newly reclaimed sites soon after applying the liming materials. Although it would have been sounder agricultural practice to take a less sensitive crop first so as to allow time for the liming materials to become more thoroughly incorporated through the plough layer, the effects on sugar beet and other early crops in this series of experiments provide a drastic test of the immediate values of the alternative liming materials.

As would be expected, sugar beet, mangolds and barley showed large benefits from liming, crop yields on the average being doubled by the full rate of application. A striking result, illustrated in Table 2, was amply confirmed in the other series of experiments and may therefore be regarded as general. Even where liming materials applied at the estimated " lime-requirement rates " doubled crop yields, dressings at half these rates increased crop yields by as much as 85 per cent. Although the full rate of dressing may sometimes prove profitable, there must be large areas of land which would give very high returns for quite modest applications of liming materials. On many farms with acid soils it would be a better investment to work round most of the farms quickly with light dressings than to proceed piecemeal with heavy ones.

It will be seen from Table 2 that, for all crops, the fine and medium fractions of limestone gave yields closely similar to those from equivalent amounts of burnt lime. The coarse fraction (with only 9 per cent passing a 40-mesh sieve) was better than half the equivalent amount of burnt lime, on the average of all crops. There were only small differences between the three limestone fractions and the burnt lime in the experiments on mangolds and

hay. The fact that the limestone fractions showed their highest differences on sugar beet probably depends on the circumstance that this crop was sown soon after applying the materials and before the coarser fractions had had sufficient time to react with the soil. These experiments show that in choosing a ground limestone, it is not necessary to insist on fine grinding—even fairly coarse limestone acts quickly.

Table 2

Burnt Carboniferous Lime and Limestone Fractions

	Sugar Beet	Mangolds	Barley	Hay	Other Crops*	All Crops
Number of crops	3	9	5	7	9	33
Number of sites	3	8	4	4	6	11
	Actual Crop Yields per Acre				Relative Yields	
	Roots *tons*	Roots *tons*	Grain *cwt.*	*cwt.*		
No liming material	3.9	8.6	11.7	30.7	57	56
Burnt lime						
Half rate	6.5	18.6	20.5	36.0	106	103
Full rate	7.4	20.6	22.1	37.1	111	111
Limestone fractions at full rate						
Coarse	6.7	20.2	20.7	38.0	105	106
Medium	7.4	20.4	21.3	38.0	108	110
Fine	7.7	20.6	21.8	38.6	113	113

* Based on actual yields of peas, swedes and turnips, estimated yields of grass, clover and barley.

Ground Limestones of Varying Fineness Four commercial grades of ground Carboniferous limestone applied at the standard lime-requirement rate were compared with ground burnt lime at this rate and at the half rate : the results are summarized in Table 3. These limestones, which necessarily contained a range of particle sizes, were characterized by the percentages passing the 100-mesh sieve. The coarsest, with only 22 per cent through this sieve, is sometimes referred to as " limestone dust " ; it is the by-product of road-stone crushing. The next grade, with 33 per cent through the 100-mesh sieve, is also rather coarse. The material with 52 per cent through the 100-mesh sieve is close to the general average of commercial forms of ground limestone, though a few firms market a finer grade with 80 per cent through the 100-mesh sieve. The finest material tested in this series, all passing the 100-mesh sieve, is sometimes known as " cyclone-dust".

Table 3

Carboniferous Limestones of Varying Degrees of Fineness

	Root Crops	Other Crops*	All Crops
Number of test crops	4	7	11
Number of sites	3	4	5
	Actual Yields per Acre *tons roots*	Relative Yields	
No liming material	14.1	58	62
Burnt lime			
Half rate	20.6	97	98
Full rate	21.4	105	105
Ground limestone at full rate			
22 per cent through 100-mesh	21.4	110	108
35 " " "	21.8	107	107
52 " " "	22.3	110	109
100 " " "	22.4	112	111

* Actual yields of hay and wheat, estimated yields of seeds hay, barley, rape.

For four root crops on three sites, the yields increased slightly with increasing fineness of limestone, but all the limestones yielded at least as well as the equivalent amount of burnt lime. The " other crops " in this series were generally the second crop after liming. They showed smaller differences between the limestones and a slightly greater superiority of limestones over equivalent burnt lime. As in the series of experiments on limestone fractions, highly responsive centres showed only small gains from increasing the rate of application from half lime-requirement to full lime-requirement.

Magnesian Limes and Limestones For many decades there has been a prejudice in the United Kingdom against the use of magnesian or dolomitic limes and limestones. This may have arisen from occasional instances of damage to crops or swards where very heavy applications of burnt magnesian lime were left below heaps piled for slaking in the field. The value of the magnesium oxide and carbonate for neutralizing soil acids and for supplying a plant nutrient were not recognized in the analytical methods prescribed in the 1926 and 1932 regulations of the Fertiliser and Feeding Stuffs Act, though magnesian limestones are highly favoured in many other countries and have received the usual subsidy here. Since the atomic weight of magnesium is less than that of calcium, magnesian limes and limestones have a slightly higher neutralizing value per unit weight than high-calcium materials of similar purity. Indeed, the neutralizing value of a magnesian lime, expressed in terms of pure calcium oxide (CaO), may exceed 100 per cent. H. T. Jones has recently [1] reviewed the general question of magnesian liming materials, using many of the results from the series of experiments. It is not therefore necessary to discuss them in detail here. The results in Table 4 are for materials at equivalent rates, half and full " lime-requirement " rates being averaged in most experiments.

Table 4

High-Calcium and Magnesian Limes and Limestones

	Sugar Beet	Mangolds	Barley	Other Crops*	All Crops
Number of test crops	4	8	5	9	26
Number of sites	3	7	5	6	10
	Actual Yields per Acre			Relative Yields	
	Roots *tons*	Roots *tons*	Grain *cwt.*		
No liming material	0.0	5.6	5.3	60	40
High-calcium lime	3.3	14.3	17.5	113	112
High-calcium limestone	3.8	14.9	17.1	110	114
Magnesian lime	4.7	15.2	16.6	108	118
Magnesian limestone	4.5	14.8	16.1	110	116

* Actual yields of swedes, turnips, grass, wheat ; estimated yields of carrots, seeds hay, clover, oats and barley.

The sugar beet crops were either the first or second crops after applying the liming materials, the mangolds generally the second crop, and the barley the third. The sugar beet and mangold yields were generally low, as the sites were chosen on very poor, shallow soils of coarse texture and high acidity ; they were essentially reclamation sites. Sugar beet gave considerably better results from the magnesian than from the high-calcium materials. With mangolds, too, the magnesian materials showed a slight superiority. With barley, the high-calcium materials gave rather higher yields. It is not possible from this series of experiments to decide whether the root crops gained some advantage from the magnesium as a nutrient or whether the

magnesian materials, being softer, acted a little more quickly, but the general result is clear. Magnesian or dolomitic limes and limestones should be valued in terms of their neutralizing values and used in the same way as high-calcium materials. Two minor qualifications must be made : the use of magnesian limestone will reduce the risk of magnesium deficiency, especially on light soils which have been reclaimed, heavily manured or used for growing fruit ; and heavy dressings of burnt magnesian lime—say over 2 tons per acre—should be avoided, as there is some risk that the free magnesia present may remain caustic too long. It may be noted in this connection that the sugar test sometimes employed for estimating free calcium oxide or " caustic lime " excludes the magnesia present in a magnesian lime. Such a material would show a low value for " caustic lime," but might prove to be more dangerously caustic when applied in the field at heavy dressings than high-calcium limes showing much more "free" or "caustic" lime.

Other Liming Materials Ground Oolitic limestone gave results closely similar to ground Carboniferous limestone. A number of waste limes—tar distillery waste, sugar beet lime, waste lime from paper works, and various other chemical wastes—were compared in a smaller number of experiments. All these materials gave similar results when tested at equivalent rates in terms of neutralizing values.

Rate of Action of Alternative Liming Materials As has already been pointed out, these experiments were not suitable for comparing the rates of action and the duration of the effects of alternative kinds of limestone. In accordance with normal farm practice, the liming materials were generally applied shortly before taking one of the crops known to be most sensitive to soil acidity, and less sensitive crops were commonly taken in the later years. Some indication of the duration of the effects is given in Table 5 by averaging the relative yields of all crops for the five seasons 1944 to 1948, inclusive for experiments started in either 1944 or 1945. The same centres are not represented each year, because it was not always possible to harvest the crops and a few experiments had to be discontinued. The average results for individual years show at least that the results were broadly similar in each of the four seasons. Residual effects were similar to the immediate effects. In two years (1944 and 1946) the limestone gave slightly higher yields than the equivalent amount of burnt lime. In the other two years the differences, though very small, were in the same direction.

Table 5

Mean Yield for Results Expressed as Percentages for each Centre and Season

	1944	1945	1946	1947	1948	Total All Years
Number of test crops	9	16	10	11	4	50
No liming material	66	52	66	70	26	59
Burnt lime						
Half rate	104	106	106	104	102	105
Full rate	112	120	112	113	136	116
Limestone						
Full rate	117	122	117	114	136	119

Summary of Experimental Results Findings in the earlier tables show that there is no experimental evidence to support the traditional preference for burnt lime. The normal commercial grades of ground limestone are at least as good as burnt lime when used at

rates equivalent in neutralizing value, i.e., roughly twice as much limestone as burnt lime. Indeed, there is fairly consistent evidence that the advantage lies with the limestone. This may be due to the circumstance that the limestones can be spread more evenly and incorporated more uniformly throughout the soil. In a few of the experiments, where the liming materials were applied very shortly before sowing sugar beet or other very sensitive crops on acutely acid land undergoing reclamation, there were slight advantages from the burnt lime, the finest grades of limestone and the magnesian materials over other forms.

If liming materials are applied sufficiently long ahead of sowing to allow their products to be well incorporated throughout the soils, the differences between the alternative forms are very small indeed. The choice between them should be made in terms of delivered cost per unit of neutralizing value, provided the forms considered can be spread equally well. Wet or lumpy materials must be used at much higher rates to allow for inevitable irregularities in distribution. To use moderate dressings frequently will generally be more profitable than to use heavy dressings occasionally, because the immediate returns on the outlay are relatively greater. In addition, repeated small applications will ensure greater uniformity within the soil and less risk of failure on acid spots.

Specially designed experiments of long duration and strictly controlled rotations, with each crop tested every year, will be required to produce precise and reliable data on the relative rates of action and the duration of the effects of alternative forms.

Soil Studies Advisory chemists followed the chemical changes in the soils of a number of these experiments, and the results have been discussed by Walker[2]. It is generally agreed that the optimal soil reaction to allow freedom of cropping and good yields corresponds with a *p*H value of around 6.5. The present series of experiments were based on the rates required to give *p*H values of around 6.3 in a conventional laboratory test. It is well known that when liming materials are applied to acid soils in the field at these estimated rates, the *p*H value does not rise as high as 6.3. To allow for this, some soil chemists, especially those working in the drier parts of the country, commonly recommend liming at *twice* the rate indicated by laboratory tests. Unfortunately, few of the field tests summarized here were in the drier parts of the country and this recommendation cannot be properly tested. In the wetter parts, the present results suggest that dressings at rates equivalent to the conventional laboratory rates are ample. In very wet areas many crops thrive at lower *p*H values than in dry regions, and in Wales it has often been found more convenient to base lime dressings on the content of exchangeable calcium than on *p*H values or so-called "lime-requirements".

In this series of experiments it was noted several times that, although the crops immediately after liming showed marked improvements, the *p*H values rose only slowly but continued to increase for several years after the application. A crop may derive considerable or, indeed, almost full benefit from liming materials, before they have reacted fully with the soil. It was also observed in these, as in many other experiments, that the *p*H value of a soil may vary markedly throughout the year, falling in summer and rising in winter. This reflects the effects of soluble salts, such as nitrates and sulphates, on the equilibrium between the soil and water. To smooth out these seasonal irregularities, some soil chemists prefer to make all their *p*H measurements in a dilute salt solution (e.g., 0.02 N $CaCl_2$) to mask the effects of inevitable

fluctuations in soluble salt contents of soils. In many soils, the *p*H values measured in dilute salt solutions may be anything up to one unit lower than those measured in water, and appropriate adjustments must be made in basing recommendations on the *p*H values.

Some Practical Conclusions The experiments summarized here show that the principal alternative forms of liming materials give closely similar yields when used at equivalent rates in terms of neutralizing value, which is commonly expressed as a percentage of calcium oxide. On this basis, ground limestones, which are generally ground to give about 40 per cent through the 100-mesh sieve, are fully as effective as equivalent amounts of burnt lime. Coarser limestones act more slowly, but an appreciable proportion of a gritty material in a ground limestone improves its physical condition. Ground limestones have great advantages over burnt limes in the ease with which they can be stored, handled and spread. Ground limestones are incorporated more evenly into the soil and may be applied without risk of damage to growing crops and herbage. Burnt lime is about twice as concentrated as ground limestone and is to be preferred only where transport and spreading costs are so high that the cost of unit neutralizing value (or CaO equivalent) is appreciably cheaper in the more concentrated form. Wet and lumpy waste limes must be used at much higher rates than those equivalent to the standard forms so as to allow for the more irregular distribution and incorporation. Waste limes should therefore be used only where the initial transport and handling costs, taken together, are low per unit of neutralizing value. Where these conditions are satisfactory, any of the waste limes approved by the Agricultural Lime Department of the Ministry of Agriculture may be used with confidence.

Magnesian limes and limestones have sometimes given slightly better results than equivalent amounts of high-calcium materials, when tested in single dressings at moderate rates. The magnesian materials behaved especially well in the initial reclamation of very acid light land. In some of the experiments there may have been a benefit from the nutritional value of the magnesium as distinct from the simple reduction of soil acidity. Occasional dressings of magnesian limestones may help to insure against the risk of magnesium deficiency in sensitive crops, but until more evidence has been obtained the advice of the Advisory Soil Chemist should be sought before using heavy dressings of magnesian limes or repeated dressings of magnesian limestones.

Liming materials applied at the rates indicated by the usual laboratory tests will generally give marked responses of sensitive crops on very acid soils. Normal farm rotations generally include a higher proportion of the less sensitive crops than was employed in the present series of experiments. Under such conditions there is little to be gained from liming at higher rates than are indicated by the laboratory tests, and it will often prove more economic to use even smaller dressings and to repeat them after a few years where further soil tests show this to be advisable. It has often been stated that the greatest freedom of cropping and the best returns are obtained when the *p*H value of the soil is around 6.5. In the present series of experiments, starting with very acid soils, yields approaching optimal were obtained when the *p*H value was raised to about 6.0. As has been pointed out, the *p*H of the soil continued to rise slightly for a few years after liming. There is, therefore, little point in testing the soil again for a few years after liming at the estimated lime-requirement rate. But with most rotations it would often be worth while to have the soil tested again, say, four years after liming or,

alternatively, to give a further dressing of about 30–40 cwt. ground limestone per acre. Higher rates of liming may be needed in the drier parts of the country since the effects of soil acidity are aggravated during droughts. More experiments are needed to determine the best " liming factor " under these conditions.

Greater Use of Lime. Several changes in general farming practice during the last dozen years have increased the need for liming either more frequently or at heavier rates than sufficed in the past. Calculations of lime-requirements are commonly based on a conventional ploughing depth of about 7–8 inches, but many farmers now plough much more deeply than this, and heavier rates of liming are needed to deal with the large quantity of soil through which the liming material is distributed. Subsoils are sometimes more acid than surface soils, and a number of crop failures have occurred where farmers have ploughed deeply for the first time and have brought raw acid subsoil to the surface. On the other hand, there are soils, especially in permanent grass fields on heavy clays, where the subsoil may be on the alkaline side and the surface soil below the old sward strongly acid. It is generally better to apply liming materials on ploughed land than to lime and then immediately plough down the lime. In reclaiming very acid soils to be ploughed fairly deeply, it would often pay to plough down one dressing of liming material and to apply another dressing on the newly-ploughed land.

Nitrogen Fertilizers. The use of nitrogen fertilizers has been trebled in the last dozen years and it must be remembered that the bulk of this nitrogen, especially in compound fertilizers of the ordinary strength, is derived from sulphate of ammonium. This fertilizer necessarily increases the rate of loss of lime from soils. In soils well supplied with lime, each unit of nitrogen applied as ammonium sulphate removes from the soil in drainage about four times its weight of calcium oxide in excess of what would have been lost if the nitrogen had been given as sodium nitrate, calcium nitrate or " Nitro-Chalk." The extra loss of lime through using ammonium sulphate is less on acid soils than on neutral ones, but it is none the less serious, especially on light soils. Where fertilizers are used heavily on soils liable to become acid, heavier applications of liming materials are necessary to maintain a steady state. It is probably for this reason that farmers who cultivate and manure intensively prefer to work at higher *p*H values than appeared to be required in the present series of experiments. They prefer to ensure that the soil remains near the optimal *p*H value after heavy manuring and that there is little risk of occasional pockets of acid soil where the lime supply has fallen too low.

To be sure of reaping the full benefit, liming should be carried out well ahead of sowing the seeds of sensitive crops, especially where the soil was originally very acid. Otherwise, the liming material and its products may not be diffused sufficiently well throughout the soil. Indeed, on very acid soils it would be better to grow the less sensitive crops in the first year or two after liming. Where the soil was only moderately acid before liming the more sensitive crops may be grown immediately after liming, but steps should be taken to work the liming material into the soil as well as possible.

The Meaning of the word "Lime". It is possible that a certain amount of confusion may have arisen in the past through ambiguous use of the word "lime." Sometimes this word is used to denote only the forms consisting mainly of calcium (and magnesium) oxide and obtained by burning limestones. Some farmers may think of limestone as a raw material and burnt lime as a prepared product in much the same way as rock phosphate is the raw material

from which superphosphate and ammonium phosphate are made. There is, however, the important difference that, when compared on an equivalent basis, ground limestone works as well as burnt lime on all kinds of soil. Superphosphate, however, is better than an equivalent amount of rock phosphate on most kinds of soil and, in addition, works very well on neutral or calcareous soils for which rock phosphate is almost useless. The word "lime" is also often used as a general term to cover all kinds of liming materials; thus we speak of "lime-requirements" or the "Agricultural Lime Subsidy" without limiting the term to the liming materials containing "lime" in the narrow sense of calcium (or magnesium) oxide. There is, in fact, no established evidence that the oxides (burnt lime) give better crops than the carbonates (limestones), provided both classes of material are used at equivalent rates and are incorporated equally well with the soil.

The Choice. Provided burnt lime or limestone are used at something approaching the lime-requirement rate, the form chosen and the precise rate of application are of little, if any, importance. After taking into account the cost of transport and spreading, the ease and uniformity of incorporation, and allowing for the subsidy, farmers should select the form which supplies the desired neutralizing value (expressed as equivalent calcium oxide) at the lowest cost.

With the soil testing facilities offered by the National Agricultural Advisory Service, the approval of forms of liming materials by the Agricultural Lime Department, the liming subsidy and the simple conclusions reached from the present series of experiments, there should be good grounds for expecting a more economic and efficient use of liming materials generally. Extravagant rates of application or choice of forms should be avoided, especially on land with low immediate requirements. Quite moderate rates of application of the cheapest form available in the district would do a great deal to improve the value and productivity of that large area of second- or third-class land which still remains short of lime.

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THE LUCERNE LEY IN ARABLE FARMING

R. A. FORTESCUE

Attention is drawn to the advantages of lucerne for grazing, silage, hay and drying, and the place that lucerne leys can take in arable rotations.

SINCE 1939, national policy has required the maximum production of home-grown food. This policy has produced a spate of new ideas and the rapid development of older ideas which had previously been shelved owing to the agricultural depression. The speed with which these ideas have been brought into practice has not been conducive to maximum efficiency or economy. Shortages and uncertain deliveries have made it difficult for farmers to plan their systems to the best advantage ; they have only too often had to buy the machines, feedingstuffs and fertilizers that were available rather than those they would otherwise have chosen. During this period the business side of farming has been obscured to some extent by the various subsidies, controls, directions of cropping and changes of emphasis imposed by the Government from time to time. These factors have made it difficult to see the true costs of production or to discover the true prices of agricultural products. They must be ascertained if a secure and long-term farming policy is to be evolved.

During the war the cost of increased home production was of secondary importance and the cost of food to the consumer was heavily subsidized. It is now becoming increasingly apparent that the country cannot afford these subsidies indefinitely and that costs must eventually be lowered if the present standard of living is to be maintained. Farmers in this country will naturally be in a stronger political position if they can reduce their costs to compare more favourably with those of farmers in the food-exporting countries. It is therefore the purpose of this article to examine briefly some of the developments of the last twelve years in so far as they affect arable farming, and to suggest a way in which these farming systems might be altered to their own advantage and to the advantage of stock farms in the west and north of the country.

Recent Developments and Present Systems Increased mechanization has undoubtedly produced the most obvious changes in arable farming. Mechanization came rapidly to enable the arable acreage to be increased at a time when many agricultural workers were being taken for the Armed Forces. Increased mechanization has not, however, been accompanied by as great an increase in the output per man as might have been expected. In the national interest a high output per man is required as well as high output per acre. From the individual farmer's point of view the costs he incurs by mechanization must be recovered by either increased output or by a saving in his labour cost. It should therefore be appreciated that while such jobs as corn harvesting can be completely mechanized, others such as sugar beet singling still require much hand-labour. It must therefore be the first aim of a good farming system to arrange for the labour force to be employed on essential work throughout the year. Secondly, the crops to be grown must suit the particular soil and climate, and then only those crops should be selected which meet this first essential and can form the basis of a rotation complying with the rules of good husbandry.

A further complication may arise where it is necessary to grow high value crops and to farm more intensively on holdings carrying a high rent charge ;

rent, however, now constitutes a relatively small proportion of total costs, and this factor is only likely to be of importance when planning a system for a new farm or where the farm lies on a particularly rich soil. To illustrate this point by extreme examples, a Fenland farm growing a large acreage of vegetables and other root crops requiring a large labour force will often not be able to justify the mechanized harvesting of relatively small acreages of hay and cereals ; labour will be available to tripod the hay and to harvest the corn with a binder, and the improved quality of both crops will be an incidental advantage. Conversely, an extensive arable farm in a remote district is unlikely to grow an appreciable acreage of such crops as strawberries or celery which require a lot of hand work for limited periods ; this farm might, however, grow a few acres of late carrots which could be drilled between hay-time and the corn harvest and be lifted after potatoes and sugar beet had been cleared, thus lengthening the useful working period for an existing labour force. Further economies in mechanization may in the future be secured through standardization of equipment and an improved standard of maintenance.

Another important development is the introduction of chemical weed-killers. These will deal with most of the troublesome annual weeds found in arable districts and have improved cereal yields by removing weed competition and enabling land to be kept clean with a relatively small acreage of cleaning crops and fallows. It may well be possible further to reduce costs by omitting some tillage operations before sowing and to rely more and more on chemicals to control weed growth.

Much work has been done to discover the fertilizer requirements of different crops on each type of soil. This knowledge, combined with the use of compound fertilizers through a combine drill, has led to more efficient use of fertilizers and reduced the cost of mixing and local haulage. Plant breeders, too, have been busy on many crops, and careful choice of variety can bring large improvements in yield or quality—often both. A most valuable contribution to light land farming has been the introduction of the new spring wheats.

The main change in the livestock population of the lighter arable farms has been the reduction in the numbers of arable sheep and yarded cattle. This has been due partly to the rationing of animal feedingstuffs and partly to the sharp rise in the cost of feeding and of labour. The true cost of feedingstuffs has been disguised by subsidies, but it is now clear that at present price levels beef cattle are only a proposition on arable farms when fattened off grass and wintered as cheaply as possible on by-products such as straw and sugar beet tops. Pigs and poultry have received a larger share of the feedingstuffs available in the last few years, and the former are at present one of the most profitable lines of livestock. Many large holdings, however, have been farmed with little or no muck or stock for over fifteen years and without any of the disastrous results which many prophesied. If an efficient way can be found of conserving the leys and other by-products which are now largely wasted on these farms it would be a major step towards increasing the winter rations of cattle in the main grassland areas of the country.

Traditional Aspects The cropping of the arable areas of the eastern counties, many of the upland chalk districts and parts of the Cotswolds vary considerably, but, as a rough generalization we may say that just over half the land under the plough is in cereals, one-quarter in roots and about one-sixth under temporary grass. This distribution of crops

might be obtained from a rotation of :

cereals—cereals—roots—cereals—roots—cereals—one-year ley.

While it is not suggested that the majority of farms use this rotation, or that by any means all farms have any fixed rotation, this distribution of crops has been taken as a basis for further examination.

Cereal crops have traditionally been the main enterprise on farms in these areas because of the favourable climate and soil conditions. Farms are generally well laid out for this purpose and the areas are well suited to produce corn crops cheaply and efficiently. Under the present economic situation satisfactory cereal prices would seem to be assured for many years to come, and it will be in the national interest for these areas to continue corn growing as their main enterprise. Cereal diseases have, however, increased during the last fifteen years and much land requires a longer rest than is customary if maximum crops are to be grown and harvested.

Root growing started when turnips replaced the bare fallow as a method of resting the land from corn growing and providing winter feed for stock. From 1870 onwards, roots for cattle feeding became progressively less profitable, but root growing received a new impetus in some areas with the coming of sugar beet as a cash root crop. Between the two wars sugar beet growing continued to show profits during the decline in cereal prices and was therefore much favoured. During this period, however, regular and casual labour were both relatively cheap and plentiful. The labour force required to hoe and lift beet could be usefully employed at other times of the year when corn was cut with a binder and threshed from stacks during the winter. Combine harvesting, the scarcity of labour and the price of pulp now make sugar beet a relatively less attractive proposition on some farms. These comments apply equally to potatoes which are largely found on the stronger land and in districts without a sugar factory. The growing of other vegetables was an innovation during the inter-war depression and became more general during the last war. Labour costs are high and, unlike sugar beet and potatoes, the crop has no certain market. In fact the freer importation of foreign vegetables makes the future of vegetable growing rather speculative.

The profitability of root growing has varied in the past, but it has given economical employment to a labour force which was required at other periods of the year. However, the primary object of growing roots has always been to improve succeeding corn crops by resting and cleaning the land and by providing winter food for cattle to turn into muck.

The ley course comes into most rotations once every six or more years, and in many instances consists of ryegrass and red clover sown down for one year. In some cases the grass is grazed, but more often it is cut for hay at a time which frequently clashes with root hoeing. Depending upon the season, there may be aftermath grazing or a crop of clover seed later in the year. Frequently, however, the produce from a one-year ley will barely cover its cost, and only in rare cases will the one-year ley earn a reasonable profit.

Ryegrass almost certainly harbours Take-all, and for this reason does not give the land the rest it requires. Some farmers are tending to sow down leys of longer duration with mixtures which are more drought resistant. Increased fertility is built up in the longer resting period and the productivity of both the ley and the succeeding cereal crop is thereby considerably increased. The produce of the ley must either be sold or be fed off and cashed in the form of meat or milk. Some trade is done in hay despite

the erratic weather, increased freight rates and the high cost of baling wire during recent years. The practice of grazing ryegrass leys throughout the summer entails supplementary feeding during a dry time and almost certainly during July and August. However, some of these leys, and in particular the longer leys where cocksfoot is included, are grazed by beef cattle. Most of the dairy herds in the eastern counties are found on farms which include coastal marshes or riverside meadows, while sheep have nearly vanished in this district. A profitable means of cashing the ley is a very real problem, and it would appear that the establishment of crop drying factories which would purchase and harvest the produce of these leys would be a most helpful development ; this is discussed more fully at the end of the article.

Summary. On a mechanized farm large acreages of cereals can be grown with a comparatively small labour force. The system of resting land from corn growing by the cultivation of roots is becoming increasingly expensive as the agricultural wage increases and casual labour is less readily available. Root growing now gives rise to a seasonal demand for labour which is not now required for corn harvesting and threshing in the winter. Vegetable growing which has recently provided work out of the sugar beet and potatoes season is chancy. Leys must so far as is possible be drought resistant, and a profitable way of cashing them must be found.

Any system of farming, therefore, which economizes in labour by reducing the root shift and which reduces work at peak periods, must lower overhead costs and is worthy of consideration. The system must, of course, maintain a high level of cereal growing and leave the land in a clean, healthy and fertile condition, and be profitable.

Rotation based on Lucerne Ley A rotation based on a lucerne ley can be flexible and may be altered in accordance with livestock policy and with the relative profitability of cereals, roots and lucerne, and also to suit the supply of labour. Specimen rotations are given as suggestions only, and it will be seen that the essential points of each rotation are similar and can be summarized as follows : (1) the cereal acreage can be maintained at a high level ; (2) the frequency of the root shift is reduced, thereby saving much labour, the bastard fallow prior to sowing lucerne helping to clean the land. (3) As the lucerne may be left down from two to five years, the land has only to be ploughed and drilled once during this period, thus reducing demands on labour and machinery and lowering overhead costs.

Year	A	B	C
1	Lucerne sown after Bastard Fallow	Lucerne sown after Bastard Fallow	Lucerne sown after Bastard Fallow
2	Lucerne	Lucerne	Lucerne
3	Lucerne	Lucerne	Lucerne
4	*(Lucerne)	*(Lucerne)	*(Lucerne)
5	Cereal	Cereal	Cereal
6	Cereal	Cereal	Cereal
7	Roots or Fallow Crop	Roots or Peas	Cereal
8	Cereal	Cereal	Roots or Fallow Crop
9	(Cereal)	Cereal	Cereal
10		Roots	Cereal
11		Cereal	
No. of shifts	7—10	10—12	9—11
No. of cereal shifts	3 or 4	5	5
No. of root shifts	0 or 1	1 or 2	0 or 1

* Lucerne can remain down for two to four years.

Rotation A would suit a farm which has been previously over-corned and follows traditional lines.

Rotation B is suitable for a farm in a good state of fertility with an adequate labour force to grow a larger acreage of roots.

Rotation C, while similar to B, requires a minimum labour force.

The rotations may be varied to meet particular circumstances or to include special crops. Where the land is reasonably clean the lucerne may be sown under white mustard. The fertility built up by the lucerne may well be cashed by a remunerative cash root crop such as sugar beet or potatoes, and the latter might well follow lucerne. It is thought, however, that the old lucerne roots might impede the mechanical hoeing of sugar beet if grown directly after ploughing in the lucerne.

Utilization of Lucerne Leys Lucerne, being more drought resistant than other herbage plants, will, even in the drier parts of the country, produce twice as much feed as can be obtained from grass leys. The increased yield is obtained during the summer months when grass is normally scarce, and is thus particularly valuable. Lucerne has a high protein content as compared with grass ; in the early stages of growth the protein content will be over 20 per cent and it rarely drops below 16 per cent. The lack of carbohydrates in lucerne can be made up, if required, by the inclusion of a grass in the seed mixture. The costs of growing a good crop are lower than those for grass leys under intensive management, since lucerne, being a leguminous plant, does not require expensive top dressings of nitrogenous fertilizer.

Grazing. Lucerne provides excellent grazing throughout the season and is particularly useful during July and August. The crop is often said to be the cause of "bloat", although many farmers graze lucerne without ill-effects. This tendency may, however, be prevented by including a small quantity of grass seed in the mixture and accustoming cattle to lucerne grazing at an early age. Any companion grass for lucerne should be of a late-flowering variety, and while cocksfoot may be the best companion grass to sow in the eastern counties, meadow fescue or timothy, which flower later, are probably better in areas of higher rainfall. Grazing should be controlled and the lucerne eaten off quickly and then allowed a period to recover. Alternate cutting and grazing is often practicable and will tend to lengthen the life of the stand.

Hay and Silage. Three or four cuts may be obtained each year. Excellent hay may be made on tripods, but with normal haymaking methods excessive leaf shedding is likely to occur. Good silage is easily made, provided it is realized that lucerne contains less carbohydrates than other leys. For this reason correct fermentation should be encouraged by the addition of molasses or by slow filling in order to allow the material to reach the correct temperature. The inclusion of a grass in the seed mixture enables silage to be made more easily.

Drying. Lucerne is the mainstay of most crop driers in the eastern counties, owing to its regular growth and uniformly high protein content. Many farmers now have their own driers which produce a high quality product both for use on the farm and for sale. A crop drying factory has been set up in Norfolk which harvests and dries the produce from 2,500 acres and uses the dried lucerne in the manufacture of National Cattle Foods Nos. 6 and 7. These are then sold in the more heavily stocked parts of the country. In this way the unwanted produce of leys in arable areas can be made available to those farmers who, in the past, have relied on imported feedingstuffs.

THE LUCERNE LEY IN ARABLE FARMING

With the current price of lucerne at £8 per dry ton, an acre of lucerne will give a gross return of £24 to £32 per annum, and at this price it may well be both the easiest and most profitable method of cashing the ley, and will certainly relieve the farmer of the task of finding capital for buildings, stock and haymaking or silage machinery.

Farm grass driers can be operated economically only for a period of six or seven months in the year, giving rise to a further demand for seasonal labour, whereas the aim of this article has been to urge the planning of a farming system whereby labour can be economically employed throughout the year. It is therefore suggested that there is an extension of the factory drying plants which are able to serve large areas in the same way as a sugar factory. The factories can employ their labour economically throughout the year by manufacturing compound foods in the winter months from stocks of dried grass which have been built up during the summer. Large-scale factory equipment, the services of skilled staff and a laboratory are required for this type of operation, which is therefore outside the scope of individual farmers or even groups of farms working as a co-operative.

LUCERNE ESTABLISHMENT TRIALS IN THE WEST MIDLANDS, 1947-51

J. DAVIES, B.SC.

National Agricultural Advisory Service, West Midland Province

How do you get a good stand of lucerne ? With or without companion grasses or a cover crop ? Some answers to these questions are supplied by four years' West Midland experiences.

IN 1947, lucerne observation trials were sown at eighteen centres in the West Midland Province. It was the intention that these trials would be used to study : (a) the behaviour of lucerne and its establishment under different soil and farming conditions, and (b) the need of a grass companion plant for lucerne. The trials consisted of single plots without replication at any one centre. The following were the mixtures used :

	I	II	III	IV	V*	VI
Lucerne (Provence or Grimm)	15	15	15	15	15	15
Cocksfoot (S.37)	3	—	—	—	—	—
Timothy (S.48 or S.51)	—	5	—	—	—	—
Meadow fescue (S.53 or S.215)	—	—	5	—	—	—
Perennial ryegrass (S.24)	—	—	—	3	—	—
Italian ryegrass	—	—	—	—	2	—
White clover (S.100)	½	½	½	½	½	½
Wild white clover	½	½	½	½	½	½

* Sown at two centres only.

Establishment At four centres the mixtures were undersown in spring corn, and gave a poor establishment of lucerne. Three of these failures could be attributed to crop competition and the fourth to the non-inoculation of the lucerne seed before sowing. Sowings at the remaining fourteen centres were direct, and of these seven were around mid-April, five during May, one in July, and one centre was resown in May after failure

of an April sowing. Without exception, the early April sowings were disappointing. Annual weeds were a problem, and made it necessary to mow in May, thus weakening the lucerne at a most critical stage ; it soon became dominated by the companion grasses. Later sowings were more satisfactory, especially where a kill of annual weeds had been obtained before sowing. In one instance the sowing followed an early crop of potatoes and this gave exceptionally clean conditions for establishment. At the one centre where a resowing was necessary (the first sowing having been smothered by chickweed), a satisfactory establishment was made after discing and cleaning the seedbed. At nine centres only (half the total) was the establishment good enough to justify continued observation on management effects. At the other centres the project of a lucerne ley was either abandoned altogether, or the field became a grass and clover ley with a few lucerne plants scattered through it.

Absence of cover crop, time of sowing, and cleanliness of the seedbed were the critical factors in the establishment of these mixtures. Late spring sowings made it possible to prepare clean seedbeds and at the same time gave warm soil conditions for rapid lucerne germination.

Companion Plants The main arguments in favour of companion grasses in lucerne leys may be summarized as follows :

1. The grasses help to suppress weeds.
2. A mixed crop of grass and lucerne may yield more dry matter per acre than a pure stand of lucerne.
3. A mixture of grass lucerne is generally considered to be a better subject for haymaking, or grazing, than a pure stand of lucerne. (This is, of course, purely a matter of farming opinion.)
4. In regions of high rainfall, especially on retentive and poorly-drained soils where the risks of failure of lucerne are considerable, a grass companion and white clover together ensure the establishment of a ley, irrespective of the success of the lucerne.

In these trials, at all centres where conditions were favourable to the establishment of grass companions, there was a tendency for the grasses to suppress the lucerne. Of the nine centres at which a satisfactory stand of lucerne was obtained, there was one where the companion grasses made little contribution to the plots. Although all the sown species germinated well, the lucerne grew so vigorously that it suppressed the companion plants. Not until the third year did unsown grasses begin to invade the plots. At seven centres, perennial ryegrass, Italian ryegrass and cocksfoot proved too aggressive and often caused complete suppression of the lucerne. At one centre, where the soil was a very light Bunter sand, cocksfoot was the only grass which thrived and this did not become too aggressive. Meadow fescue and timothy were the least aggressive of the grasses used, meadow fescue showing the greater ability to maintain a weed-free sward.

It will be observed that all the mixtures sown contained white clover. It was hoped that the clover would give a "bottom" to the lucerne and help in keeping out weeds. This was admirable in theory but experience showed that the result depended on the management. Wherever the ley was treated primarily as a hay crop, the clover disappeared before the end of the second year. The case for its inclusion can be sustained only where the ley is grazed for at least a part of the early years ; it then becomes an insurance against the possible failure of the lucerne.

Broadly this study has shown that under the climatic conditions of the West Midlands companion grasses generally provide a safeguard against failure. Of the grasses, meadow fescue proved the most satisfactory. In the one case in which conditions favoured the lucerne more than the grasses, the latter played a very minor role.

Manuring and Management Although it was not intended to investigate the manurial needs of lucerne, some interesting facts did emerge from these trials. The need for lime-rich soil showed up time and time again ; also the importance of liming before sowing and ensuring that the lime was well worked into the seedbed. Lucerne did best on soils where phosphate and potash were ample. At a number of centres yield responses were obtained by increasing the annual phosphate and potash applications, although there were no obvious deficiency symptoms. In some instances potash appeared to be a limiting factor to the productivity and persistency of the lucerne.

It has been pointed out that no rigid system of management was attempted on these plots. Although the farmers collaborating in the trials were advised what was considered to be good practice, the management was in fact sufficiently variable to afford contrasting evidence on certain points.

Wherever lucerne was repeatedly cut at a young stage, the stand tended to thin out rapidly ; clearly, long rests are needed if lucerne is to thrive. The autumn rest period seemed to determine the persistency over winter and the yield in the following season. Whatever cutting management is imposed, sufficient autumn growth must be made by the lucerne to go into the winter. At some centres there was a tendency for species of *Poa* to invade the ley where winter grazing was practised. Grazing is admittedly useful to control growth of companion grass, but the meadow grasses can on occasion be detrimental to the lucerne ; where they are troublesome, winter grazing should be accompanied by some form of surface harrowing.

Summary

1. It is unwise to attempt to seed down lucerne under a cover crop.
2. Clean seedbed conditions are essential to the establishment of lucerne.
3. Lucerne does best as a pure stand, but where a companion grass is used, meadow fescue has proved the most suitable companion under West Midland conditions.
4. Phosphates and potash are essential to the establishment and maintenance of lucerne.
5. The cutting management will determine the yield and persistency of lucerne.

I should like to thank those farmers in the West Midland Province who co-operated in these trials.

STOCK AND CORN ON AN EAST RIDING FARM

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Well known for his numerous show successes with pedigree Suffolk sheep, Mr. E. W. Putman farms 295 acres on the clay soils of the East Riding of Yorkshire. By careful management and reliance on home-grown foods, he manages to achieve a high rate of stocking while, at the same time, devotes nearly half the farm to the traditional corn production of the area.

IN the East Riding of Yorkshire, between the Yorkshire Wolds and the sea, lies an almost flat, arable, corn-growing area with soil mainly composed of boulder clay varying from light glacial drift to strong clay, but with clay predominating. Towards the north of this area, Mr. E. W. PUTMAN farms 295 acres at Gransmoor, about 6 miles south-west of Bridlington. His, like the other farms in this area, is a corn-growing farm. About 125 acres of corn are sown each year, including 40 acres of wheat. In addition, there are about 12 acres of potatoes, 40 acres of turnips, swedes and mangolds for stock, 55 acres of clover, and 58 acres of leys ranging from 2 to 6 years' old. The soil varies from medium glacial drift near the farmstead to heavy clay in some of the outlying fields.

An accredited flock of 2,500 hens is kept for the production and sale of day-old chicks. There are 18 Large White breeding sows, from which the offspring are fed up to bacon weights in the foldyards. Each spring, 30–40 bullocks are bought and fed on the leys. And not least, there is a very fine flock of pedigree Suffolk sheep with 120 breeding ewes.

The permanent labour force consists of 11 men, of whom 5 are employed on general farm work, 3 with the poultry, 2 mainly with sheep and 1 with pigs and and on other duties.

Although poultry, pigs, and ewes for fat lamb production have been kept since Mr. Putman started farming in 1921, they were greatly developed after the slump in corn prices in 1929. This was especially noticeable in the case of poultry ; the flock, then a commercial one, was increased to 4,000 laying birds.

Success with Pedigree Suffolks The pedigree Suffolk flock of sheep was started with a few ewes and a ram in 1928, and Mr. Putman's success with Suffolks has been so remarkable in the short space of twenty-three years that it is worth recording the development and management of the flock in some detail. Last year Mr. Putman's list of show successes for his Suffolks included the Reserve Female Champion and two seconds at the Royal Show, three firsts and the Champion Cup at the Yorkshire Show, and the Venning Cup for the best single ram at the Ipswich Sale. (Foot-and-mouth disease has prevented his sending entries to shows since.)

At first, Mr. Putman started with commercial crossbred fat lambs, and soon his natural aptitude and love for sheep led to the winning of many prizes at local shows for his fat lambs. At different times he tried no less than five different breeds or crosses of ewes, and seven different breeds of rams, but he had the greatest success with Suffolks and he gradually concentrated on them.

In 1928, while still running his commercial stock, he bought a few pedigree Suffolk ewes. He wanted something better than crossbreds, and the shepherd was very keen to go in for pedigree Suffolks. As conditions improved and the slump was left behind, the flock became, in time, all pedigree Suffolks. Now, there are about 120 pedigree ewes with their followers, from which about 60 rams are sold each season.

How has this success been obtained ? Mr. Putman says that a good shepherd is essential (his shepherd lives for his sheep and his idea of a holiday is to go and see more sheep). Management, culling, hygiene, feeding and maintaining the health of the sheep are all very important, but, in his opinion, the most important part of all is to get the very best rams that one can afford. In his own case he had no real success until he bought rams at over 100 guineas ; and, of course, they had to be very carefully chosen. A certain element of luck does enter into the business, but unless everything is done right, luck does not have a proper chance to operate.

On the basis of his own experience, it is probable that Mr. Putman's advice to a beginner would be to start with ewes that have not too many faults, and to buy *good* rams—better than you think you can afford, even if it means buying fewer ewes. If one is unlucky enough to get a ram whose stock shows a fair proportion of bad faults, such as black wool or horns, discard the whole of the ewe lambs and do not use the ram again. This is essential. It is fatal to keep any of the daughters, even if they do not show these faults.

How the Sheep are Fed and Managed In regard to the management and feeding, arrangements must be made to have the correct food ready when wanted. Lambing starts about New Year's Day in a strawyard made in the stackyard open to the sky, but with shelters here and there below which the lambs can creep. When newly dropped, the lambs are penned with their mothers under cover for two or three days. They are then put with a small group in the strawyard, until it is thought that they know their mothers well enough—usually by the end of a week. At this stage they join the main body and go out to grass with their dams during the day, sleeping in the strawyard at night.

About the beginning of March, they leave the strawyard altogether and sleep out. Mangolds and swedes are fed on the grass and later, towards the end of March, the flock is folded on kale and swedes, which provides the sheep with fresh ground until the clover is ready. When they go on to clover, the feeding of concentrates to the ewes is stopped but it is continued with the lambs.

The clover is grown from a mixture of 6 lb. each of red, white and alsike clovers, with 1 lb. each of trefoil and ribgrass—a total of 20 lb. per acre. At least half the white clover is S. 100 and, if it is cheap, the whole of the white clover may be of this strain. Although this is a generous rate of seeding, it is considered advisable to use plenty since a miss or a bad take of clover would be a calamity for the sheep and would throw everything out of gear. Besides, there is its fertilizing value, and, as Mr. Putman puts it " What is an extra pound or two of clover when fertilizer costs 20s. a cwt .?"

Weaning takes place about the beginning of June, and to make it as easy as possible for the lambs, it is done by removing the ewes. The lambs remain on the clover until the autumn and are divided into two groups—ram lambs and ewe lambs, each segregated in different fields, or divisions of the same field, so that the ram lambs can have better treatment. Extra food for the lambs is grown in fields adjoining the clover ; first, small folds of

tares sown in the previous autumn and ready in June, then spring-sown tares and, finally, marrowstem kale, cabbages and "Mammoth" turnips, all of which are ready about the same time in August. Which of the latter crops is available first depends largely on the season. The rams are sold from August onwards at Ipswich, Kelso, Driffield and York : the ewe lambs continue on turnips and swedes, and about 35 culls from them are sold fat from January onwards. About 40 of the best ewe lambs are kept and go into the flock as shearlings.

In the meantime, the ewes, which have been removed from the lambs in early June, go on to scanty grass to dry up their milk and to get them in lean, fit condition before tupping time. About August 6, the ewes are split up into small flocks of about 35–40, and a suitable ram is turned into each group. No special steps are taken to flush the ewes, as sufficient lambs are born without. Each group is given a different coloured paint-mark to denote the ram used. The tups are raddled on the breast and the colours are changed every sixteen days so that it can be seen how the ewes are being settled. At the end of sixteen days, another tup is used on each group. Later, the ewes go together to form one big flock with one ram to deal with any stragglers left. They run about the farm where convenient, and, until the mangold tops are ready, they clear up the roots left by the lambs.

Poultry, Cattle and Pigs Poultry is a very important department on the farm. There is an accredited breeding flock of 2,500 Rhode Island Red hens which are mated with Ancona cocks to produce hatching eggs for the sale of day-old chicks. The incubators are run, each with a 12,000 egg capacity, and at the peak of the hatching season up to 5,000 chickens per week are hatched, sexed and sold.

The pure-bred stock from which the eggs are obtained are all bred on the farm and kept on free range. Starting in the beginning of January, the pure bred chicks, at a week old, are placed in brooders with runs attached. The brooders are sited on clean leys and are moved each morning to a fresh piece of grass. When the birds are twelve weeks old they are changed to movable, slatted-floor houses on free range out on the farm, and there they spend the rest of their lives. A short time before the breeding season commences the hens are thrown into a moult and given a rest. The whole routine is aimed at producing hardy, healthy, and virile breeding stock.

As regards the remaining stock, 30–40 Shorthorn and Friesian cross bullocks are bought each spring and fed off the grass, which at a later date is useful for the sheep. The strawyards and boxes accommodate 18 Large White breeding sows and their litters, which are reared to bacon weight. All the pigs on the farm have been raised from one original sow bought some twenty-five years ago, and which reared 51 pigs in five litters. Only gilts from sows that rear ten pigs per litter or over are kept, and the present strain of pigs have good, regular-sized litters. For feeding the baconers, the fold-yard has been cheaply adapted by concreting and fencing off the pathways around it, and making continuous troughs from halved, glazed pipes which are raised a little above ground level, placed a few inches from the walls, and backed and bedded in cement. Feeding can be done in about ten minutes. The meal is poured into the troughs dry : water is turned on to wet the meal, the doors are opened, and the pigs rush in to feed. To reduce labour to a minimum, the pigs must be in sizable groups roughly of the same age. The plan is to have the sows pigging in groups at three-monthly intervals, but in practice, this cannot always be accomplished, and some

litters have to be cared for separately, thus adding to the labour required. Usually, however, these are sold off as young stores.

On the Arable Side With the full utilization of the dung from the stock, poultry, pigs and sheep, together with the generous use of fertilizers, the crops are usually heavy and good. About two-thirds of the land is medium to strong and one-third is light medium loam. In general, a five course rotation of wheat—barley or mixed corn—roots—oats—clover, is followed, but this does not apply to the land in long leys, nor to the lighter part of the farm where the course is extended to seven years by leaving the clover seeds down for two years and following with a crop of potatoes before the wheat. Usually, about 12–15 acres of clover are left down for a second year. This is done to provide fresh, clean land for about 2,000 of the poultry. The poultry droppings, plus the two years' clover, make an excellent preparation for the cash crop potatoes which follow. These are grown with fertilizers at the rate of 14 cwt. National Compound Fertilizer No. 1 per acre or 10 cwt. per acre of a more concentrated fertilizer.

Wheat. For the wheat, farmyard manure is applied on the grazed clover, which it follows shortly before harvest time. The land is dry for carting, and labour is normally available for this heavy job. In the autumn, 2 cwt. potassic super are sown by combine drill with the seed and the crop is top dressed in May with 2 cwt. "Nitro-Chalk". Only strong-strawed varieties are grown. Jubilégem was a favourite for six years, the highest yield being 10 quarters per acre, but it has now been replaced by Hybrid 46 and Nord Desprez. Yields last year were 8 quarters per acre.

Barley and Mixed Corn. The strong-strawed, Continental types of spring barley are grown, and receive 2 cwt. National Compound Fertilizer No. 1 with the seed by combine drill.

Oats are taken after the roots have been folded by sheep. They are undersown with clover seeds and, although no nitrogenous manure is applied, they get 2 cwt. potassic super per acre for the benefit of the seeds. The varieties of oats used are the strong-strawed Eagle and Sun II. Oats in this position in the rotation, allied to clean farming, provide a three years' break (roots—oats—clover) to the hosts of the fungus *cercosporella*, or Eyespot which, during the war, when wheat was grown intensively, did a great deal of damage on East Riding corn farms to winter wheat and, to a less extent, to spring barley.

The foundations of Mr. Putman's farming were laid when corn was cheap, and when it was necessary to do something more than grow corn to make a living. Now, the skill and experience acquired is being utilized to market bacon, eggs, lamb, and day-old chicks, some of the home-grown grain, and to bring the manurial value of the stock back again into the fertility cycle. It is a kind of farming which, as Mr. Putman points out, needs hard work, good men, and good luck.

VISIT TO ITALY

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The following article records some impressions of the structure of the farming industry in Italy gained by the writer in two visits to that country—in 1949 and 1951.

AGRICULTURE is by far the most important industry in Italy. More than half the population lives in the country and over a third is employed on the land, compared with about 7 per cent in England and Wales. Although the total land area is not much larger than that of the British Isles, and the population only very slightly smaller, Italy is over 90 per cent self-supporting in foodstuffs. Indeed the natural resources of the peninsula do not permit large-scale industrialization and export of manufactured goods, thus making a high degree of self-sufficiency an economic necessity ; this end is attained in spite of the fact that much of the country is covered by mountains or is not suitable for agriculture, but only at the expense of a much lower standard of living than is enjoyed by the average Englishman. Half the land is under arable cultivation (including bush and tree crops) ; the remainder is almost equally divided between forests, grassland, and miscellaneous uses.

The land must be cultivated intensively to produce almost the whole of the food requirements of her population. Small farms therefore prevail over most of the country. In 1930, only 10 per cent of the agricultural land was occupied by farms of over 2,500 hectares, and by 1948 this figure had been reduced to 5.9 per cent, showing that there was a rapid decline in the number of large holdings even before any land distribution schemes[1] came into operation. These schemes include the compulsory purchase by the government of estates, mainly in the south, and their allocation to the land-hungry peasants. Incidentally, in spite of an impression to the contrary held by many travellers, the Italian peasant works extremely hard ; English people, going out in the midday sun, see him chatting or sleeping on a bench by the roadside, but they may not know that he has already done six or seven hours work in the fields and will continue later in the cool of the evening. While camping out in the country, I have frequently been awakened before 5 a.m. by raucous shouts to ploughing oxen. It should be explained that most of the tractive power is supplied by draught cows and bullocks. Tractors are also used, especially in the north, but horses are rarely seen on the land.

I had further evidence of the industry of the Italian peasant when I spent a few happy days as the guest of a small farmer in northern Italy. Here the livestock consists of two draught cows (which provide sufficient milk for their calves and the house), one pig, a flock of geese, some hens and about twenty bee hives. Enormous quantities of peaches, plums, grapes and tomatoes are produced annually from the few irrigated acres, and each day's harvest is taken on tricycles to a nearby town ; the revenue from the sale of this fruit provides sufficient to cover the limited requirements of the household, since all the vegetables are grown at home. Needless to say, there is always plenty of home-made wine on the table. Family farms like this are to be found throughout the length of the country. In the north they are relatively prosperous, but in central and southern Italy they suffer from prolonged summer drought ; in the south extreme poverty is prevalent.

Land Tenure There are four main types : small freehold, cash tenancy, crop-sharing tenancy and large estates. The peasant proprietor is most common in the hilly and mountainous districts of the north and along the fertile, densely populated coast land of the south; more than half the farms are worked by their owners. Cash tenancy is prevalent in the north, especially in the Po valley. Crop-sharing is widespread in parts of central and southern Italy and is described below. Large estates of 200–1,000 hectares are mostly found in the south, where they are called *latifundi* ; these were originally Roman estates worked by slave labour. Nowadays hired men are employed and they usually work under a bailiff for an absentee landlord.

A very common crop-sharing system is *mezzadria* (*cf.* French *métayage*) ; large estates are divided into a number of *poderi*, each of which has its own farmhouse and cattle managed by a group of peasants. Usually a steward, or *fattore*, is put in charge of all the *poderi* to look after the interests of the landlord, who is often a townsman caring little what happens to his property as long as he gets some of the produce and a modest return on his capital. Under the *mezzadria* system the produce of the land is shared between the landlord and tenant in definite proportions which vary with the fertility of the soil and other conditions. Normally both have an equal share, but in the south, under the *terzadria* system, the peasant has to be satisfied with a third of the crops. The landlord may provide all the stock or only part, e.g., implements and seed, whilst the farmer finds the cattle. Taxes may be paid by either or by both jointly. Similar forms of land tenure also exist in France, Portugal, south-east Europe and the United States.

Count Marzotto—A Progressive Landlord Although one often hears of Italian absentee landlords who do little or nothing to help their tenants, there is today a growing number of large farmers using the most modern methods. Probably the best known of these is Count Marzotto, who recently hit the headlines of the English daily press as the first Italian industrialist ever to have declared his actual income to the taxation authorities ! There is an unfortunate fear in Italy that it is unwise to invest capital in industry in case Communism gains control in the country. Count Marzotto is doing the best thing possible to counteract this by investing enormous sums of money in various enterprises, mainly textiles, and by providing numerous social benefits for his thousands of workers.

Before leaving for Italy I was given permission to visit Count Marzotto's estate at Portogruaro, but I did not realize that he had other interests besides farming. I did not connect him, therefore, with the numerous hoardings along the main roads announcing the value of Marzotto textiles. An idea of his importance was given me when I went to collect the car on the morning of our departure from Venice, only 1½ hours before we were due at Portogruaro, 45 miles away ; I was greeted by a mechanic who announced, with a characteristic Italian shrug of the shoulders, that repairs to the car, which should have been completed the previous evening, could not be finished in less than three-quarters of an hour. My indignant protests received little attention until the magic words *Conte Marzotto* were mentioned. Immediately mechanics, electricians, welders and clerks began rushing around wildly shouting "*Conte Marzotto*," and within fifteen minutes we were driving away !

About half the 3,340 acre estate at Portogruaro is held under *mezzadria*, and the rest, including the cattle, is managed centrally. The land is irrigated

Landscape in Tuscany showing vineyards.

Photos: *Enit*

Farm buildings on reclaimed marshes near the west coast opposite the Island of Elba. Note the haystacks built around vertical poles.

Left: Tying hemp for retting in the valley of the Po.
Right: Threshing in the Roman Campagna.

Grape harvest in southern Italy

Photos: *Enit*

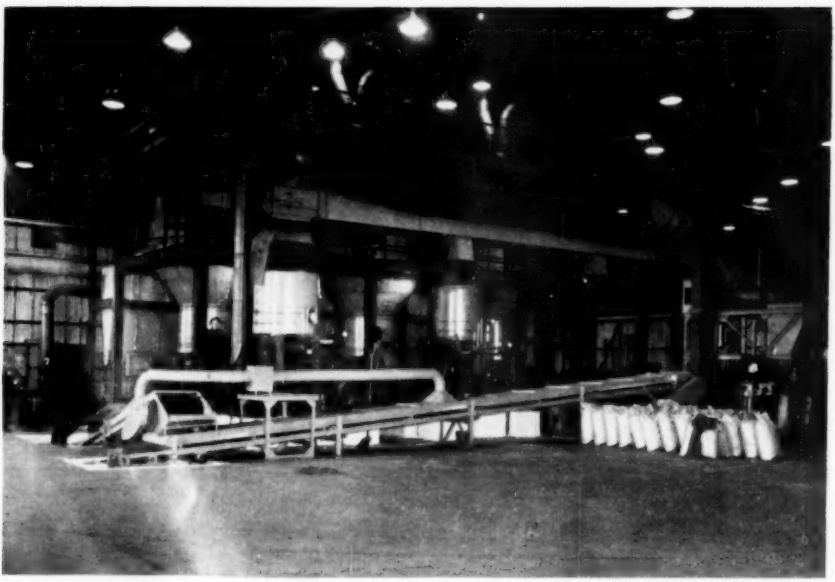
A rice field in Lombardy. The crop is sown either direct into the field, or into nurseries and later transplanted by hand (inset).

Ploughing with oxen, a common sight all over Italy.

Photos: *Enit*

A modern cowshed in northern Italy.

Lucerne being picked up and chopped with a forage harvester.



Photos: *A. E. Coe and Sons Ltd.*

Compounding and cubing plant at the British Field Products factory.

and cropped on a six-course rotation with two breaks of wheat and lucerne and one of linseed and sugar beet. Average yields are as high as 60 bushels of wheat and 15 tons of sugar beet per acre. The linseed and beet are processed in factories forming part of Count Marzotto's adjoining industrial centre, which employs 400 persons full-time and absorbs an additional 600 during the slack winter season. The wheat and linseed, harvested from the middle to the end of June, are followed by maize and peas, which, together with part of the lucerne, are ensiled in enormous reinforced concrete tower silos, each with a capacity of 2,000 metric tons.

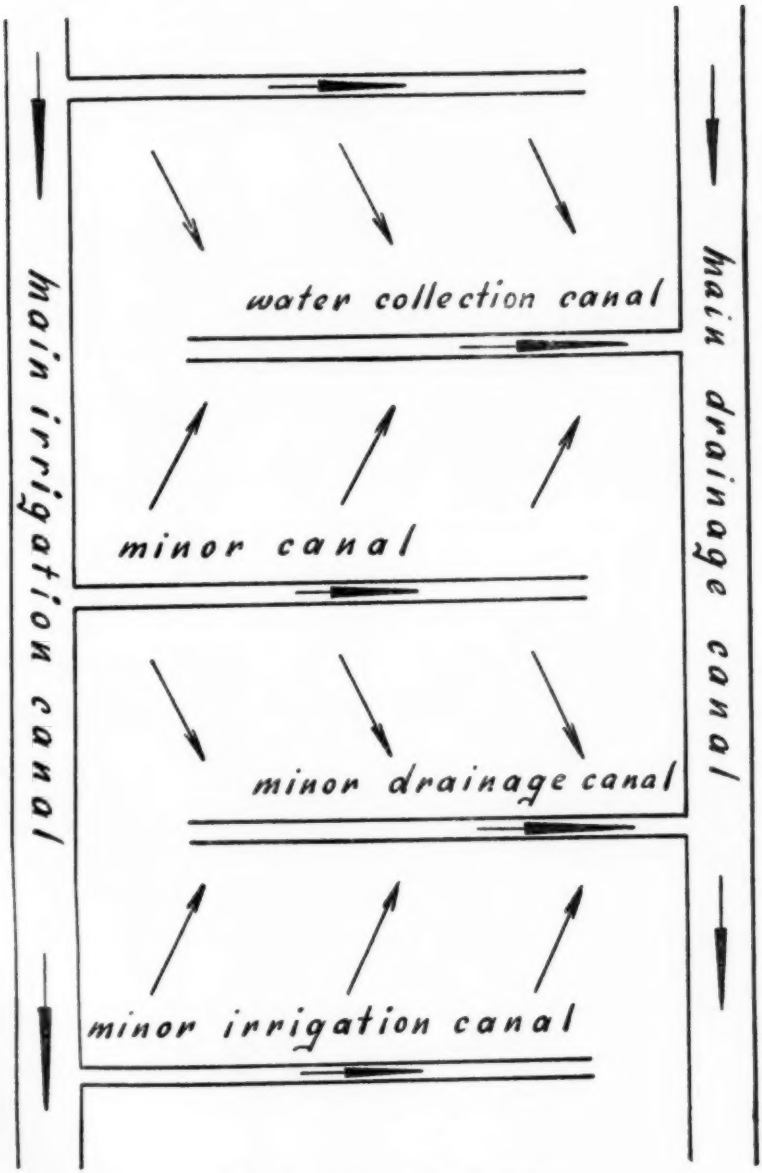
These large quantities of silage are required for the Friesian dairy herd which is kept in cowhouses all the year round ; it is never allowed out on pasture, since it is held that the land is needed for more remunerative crops. The health of the animals does not seem to suffer. A few years ago the herd numbered about 300, but it was enlarged in 1949 by importing 208 heifers and 5 bulls of the Canadian Holstein-Friesian breed ; a bull was imported from the Carnation Farm (U.S.A.) in 1950. It is aimed to have 950 milking cows by 1953. The animals are housed in a series of modern cowsheds. Milking is done by hand twice daily at 4 a.m. and 4 p.m. to the accompaniment of light music, but during early lactation high yielders are milked three times a day ; there are 12 cows per milker. The introduction of machine milking was followed by outbreaks of mastitis which prompted the resumption of hand milking, and it was concluded that the men were not capable of efficiently managing a milking machine. Manure is carted out of the cowsheds on overhead rails to small mixing wells, in which it stays for ten days, and is then transferred by a mobile crane, which probably started life in the Trieste docks, to a manure pit where it remains for four to six months. The urine is also collected and applied to the land. The maintenance ration consists mainly of silage, lucerne hay and sugar beet by-products ; the production ration, containing 16–18 per cent digestible protein and fed at the rate of 1 lb. per 3½–4 lb. milk, comprises a mineralized and vitaminized mixture of linseed cake, barley, oats, maize and bran, milled and cubed at Portogruaro. Average milk yields are as much as 9,400 lb. for Canadian heifers in their first lactation, and 8,000 lb. for the rest of the herd.

The bull house is built to accommodate about 20 bulls and has equipment for artificial insemination. In fact if it were placed on its own it could easily be mistaken for an artificial insemination centre. It has an automatic circular bull exerciser nearby. An Aberdeen-Angus and a Hereford bull, flown from England with 8 cows in 1950, are kept to serve those cows which do not come up to the required standard.

Calves are kept in stalls and fed whole milk for the first 45 days of life, followed by skim-milk and 1 lb. concentrates daily until they are four months old. They are then turned out on some land recently reclaimed from the sea, and allowed to run semi-wild. When 20–22 months old the heifers are served and they remain outside until the seventh month of pregnancy.

Several hundred Large White and Tamworth pigs, the original stock imported from England, are also kept to consume canteen swill, which is piped straight to the trough from the place of cooking.

Irrigation An invaluable contribution to agriculture in northern Italy is made by irrigation, which is helped by a fortunate combination of physical features : ample water is available from the thawed snow on the Alps, and several large lakes exist which serve to regulate the flow and store



Plan of a typical *marcita* in northern Italy.

the water. These favourable circumstances prompted the beginning of irrigation schemes as far back as the latter half of the twelfth century, and there now exists a network of canals and rivers forming part of a highly efficient scheme of irrigation. Viewed from the air, this region would in many places resemble the Fens. A further valuable source of water is provided by springs, or *fontanili*, large numbers of which emerge from the alpine side of the northern plain. Although the flow diminishes during the winter, the water at that time has the added advantage of being relatively warm. With an assured supply of water, and ample summer sunshine, it is not surprising to find that farming on the rich alluvial soils of the Po valley, with its convenient outlet for the produce in nearby towns, is relatively prosperous.

In the peninsula, however, the water problem is often acute. In some cases the need for drainage of the marshes and irrigation of other areas has been combined, and in others springs emerging from the Apennines are used, but in a relatively dry summer there is a deficiency even of drinking water, and long queues of women assemble at the village pumps during the short periods when it is made available.

Irrigated meadows are a feature of farming in parts of the northern plain ; in Piedmont about a third of the fodder production comes from this source. One of the most characteristic are the *marcite* or permanent winter meadows ; the plan of a typical *marcita* is illustrated in the diagram opposite. By submerging the fields under a slowly moving film of relatively warm spring water, growth of grass continues during the winter. At least five cuttings of grass for hay or silage are taken per year, and in rich dairy farming areas ten or more may be obtained. Although ordinary river canals are used for the *marcite*, alternative sources are preferred. Sewage canals are the most popular, not only for their valuable soil nutrients, but because fermentation raises the temperature. *Fontanili* come next in order of preference, especially near the spring head where the water is warmest, followed by drainage waters from higher levels (*colature*).

Livestock The distribution of farm animals in Italy follows a fairly well-defined pattern, mainly determined by water distribution and physical features.

Cattle. According to Pediglieri *et al.*(2) the total cattle population on December 31, 1947, was 6,876,000, dairy cattle numbering 2,255,300 of which 2,026,000 were in northern Italy : here, large numbers can be supported from the produce of the irrigated meadows, helped in some cases by a summer migration to Alpine pastures. The most numerous and widespread breed is the Brown Alpine (a sub-breed of the Swiss Brown), which forms a quarter of the whole cattle population. All other breeds, except the Friesian, have a relatively limited distribution. In the peninsula white wide-horned breeds predominate ; they are small, active and hardy, and used mainly for draught purposes. The cattle population declined by about 1,500,000 between 1940 and 1947. During that period the breed composition did not alter greatly, though there was a tendency for draught animals to be replaced by milking stock, and the percentage of Friesians increased from 2.3 to 4.5. In the dairying districts of Lombardy, milk yields average over 4,600 lb., but the mean for the whole country, including the many cows kept mainly for meat or work, is about 3,000 lb.

As mentioned above, artificial insemination is practised in Italy, where the process was first demonstrated by L. Spallanzani in 1780. The move-

ment has been making steady progress since the war, and in 1950 about 500,000 inseminations were effected. Officials of the Italian Breeders' Association, who were most anxious to help me in any way possible, told me that the aim is firstly to prove the soundness of the practice to all concerned, and then to hand over the control of the centres to the farmers.

Buffaloes. Herds of river buffaloes are still kept in marshy districts of southern Italy. An interesting description of domestic buffalo husbandry is given in an abridgment of a thesis by MacGregor(3). Their numbers declined from 19,000 to 15,000 during 1908-30, and have since diminished still further, owing to land reclamation schemes started by the Fascists. During the summer, when the marshes dry up, the herds are transferred to rough moorland grazing which keeps them going until the autumn rains. Bulls are run with the herd all the year round, except between December and March. The cows, which lactate for about 8 months, or more if pregnancy does not intervene, are milked once daily—at dawn. Although very docile, they will not let down their milk without the presence of their calves, which are penned separately from 10–14 days old. At milking time the herd is brought near to the calf enclosure, and the young animals are let out one by one as their dams are ready to be milked. The process is much facilitated by training the calves to come when their mothers are called ; both animals respond to the same name, the cow detaching herself from the waiting herd and the calf coming to the gate of the pen. The names, incidentally, are not simple ones like "Buttercup," but whole sentences which are always intoned in the same characteristic way ; the example given to me by Professor Maymone, who kindly supplied me with some of these details and who has described(4) buffalo husbandry in Italy, was *lo studente non vuole studiare* " the student does not want to study." Should a calf die, the cow is persuaded to adopt a foster calf by covering it with the skin of the dead animal. The average yield is about 225 gallons a year, excluding milk consumed by the calf sucking one or more teats while the remainder are milked. Bulls are replaced at 4–5 years, but the best cows are kept up to 18 years old. This extensive system, which gives a good return from land unsuited to other types of stock, is now being replaced by methods more in line with modern cow-keeping.

During a visit to the Institute for Research in Animal Husbandry at Rome, Professor Maymone showed me his buffalo herd which was established in 1926. The herd was closed for twenty-five years without the appearance of any hereditary lethal factors, but in 1951 a promising young bull was bought. The cows have been trained to let down their milk without their calves being present. The buffaloes are not susceptible to mastitis or brucellosis, and the only disease which may give trouble is a mild form of foot-and-mouth. Feeding is similar to that for dairy cows, except that more dry matter is allowed : both males and females weigh 13½–15 cwt. The gestation period is about 310 days, and cows at Rome produce a calf a year. The average of 172 lactations for stabled buffaloes milked twice daily was 2,000 kg. (4,400 lb.) milk, with as much as 8.11 per cent butter fat. Many cows are retained until 15–20 years old. Calves are given colostrum and then reared on the less valuable cows' milk. Most of the buffaloes' milk is used for manufacture of *Mozzarella* cheese.

Sheep and Goats. According to Maymone(5), 94.6 per cent of the sheep in Europe (excluding Russia) are raised in the countries of the Mediterranean basin. In 1938 there were 9½ million sheep in Italy, most of them on the dry, eroded hill pastures of central and southern Italy, which are not suitable for exploitation by other types of stock. This erosion has been brought

about by centuries of overgrazing by sheep, aided by hillside ploughing and destruction of young saplings by browsing goats. Because of the consequent destruction of woodlands, efforts have been made to reduce the goat population, which numbered 1,800,000 in 1938.

An interesting feature of sheep husbandry in Italy and other countries of the Mediterranean basin is the importance of milk. During the last fifty years over 60 per cent of the profits in Italian migratory flocks have resulted from the sale of such cheese as *Pecorino*, or *ricotta* (a whey cheese). The average yield in such flocks is about 50 kg. milk per head, excluding that taken by the lamb, but ewes of improved breeds average 200–300 kg. per year. In southern Italy 40 per cent of the milk is produced by sheep and goats, whilst in Sardinia as much as 65 per cent comes from sheep alone.

Farming Diversity I think that the thing which impressed me most about Italian agriculture was its diversity. This, of course, is a character shared by the British Isles, but climate and geological conditions make the contrasts in Italy more marked. In the Alpine regions the conditions are comparable with those of Switzerland. The Po valley contains irrigated, highly fertile land farmed by the most progressive methods ; large areas near Ferrara show that the Italians are as skilful as the Dutch in bringing back lost land into cultivation. The vineyards of Piedmont produce wines resembling those of France, while methods of husbandry in Sicily and the south have their equivalents in Spain, eastern Europe and Tunisia.

It will be gathered, therefore, that Italy, besides providing a happy hunting-ground for the art student and lover of good food and sunshine, has much to interest the agriculturist. Some features of the livestock industry have been mentioned, but the cropping should prove no less interesting to a visitor from this country. By travelling extensively one can see, as well as the almost universal vines and most of the common British crops, olives abounding over the peninsula (but not the continental) part, maize in central and northern Italy, especially the Po valley, rice heavily concentrated in areas of the Po valley, and citrus, cotton and tobacco in Sicily and the south. In addition, Italy is the world's second largest hemp grower and the third largest producer of silk.

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HEAT PRODUCTION AND VENTILATION OF POTATOES BULK STORED IN FARM BUILDINGS

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Experiments have been in progress to determine the right conditions of temperature, ventilation, and insulation necessary for the successful storage of potatoes. This brief outline of some of the results may be of practical assistance to farmers and others concerned with indoor storage.

EXPERIMENTS upon the indoor storage of potatoes have been in progress at the Ditton Laboratory of the Food Investigation Organization since 1946. The work has been directed mainly to determining the heat produced by stored masses of potatoes, the maximum safe dimensions of such masses, their resistance to the flow of air, the degree of ventilation necessary, and the amount of insulation required on the building. Investigations of other aspects of indoor storage, such as shrinkage, methods of handling, costs, etc., are being carried out by the Agricultural Research Council Potato Storage Investigation Team at the Nottingham University School of Agriculture, Sutton Bonington. The work at both centres has reached the stage where detailed publication of the results is possible, but this will inevitably take some time, and pending more detailed publication, brief summaries of some of the results may be of use and interest to farmers and others concerned with the storage of potatoes.

Heat Production The amount of heat produced by the respiration of stored potatoes depends upon the temperature of storage and, probably, to some extent upon the variety and season. Values obtained for Arran Consul and Majestic potatoes in 1949-50 varied from 51 B.Th.U./ton hour at 36°F. to 70 B.Th.U./ton hour at 52°F. About 2,000 B.Th.U. are required to raise the temperature of a ton of potatoes one degree Fahrenheit, and thus even at a storage temperature as low as 36°F. potatoes are producing sufficient heat to raise their own temperature by about 0.6°F. per day. At 50°F. this figure of 0.6°F. would be increased to about 0.8°F. The heat production of freshly lifted, and particularly of immature potatoes, may be two or three times those suggested above, and a few weeks may elapse before it settles down to a steady value approximating to those given.

Convection Currents in the Stored Mass Any increase in the temperature of the potatoes above that of the surrounding atmosphere will cause convection currents and there will be a continual complex circulation of air into, out of, and inside the stored mass. This circulation will follow no fixed path but will take a course dependent upon local variations in temperature and in the resistance to flow. The greater the differences in temperature that exist, the greater will be the resulting convective air flow. These currents of air transfer heat from the potatoes to the atmosphere, and provided the outside temperature remains fairly steady, a state of dynamic equilibrium will be set up in which the heat removed by convective circulation and by conduction is sufficient to counterbalance the production of heat by respiration. The average temperature of the potatoes will therefore rise to a level above that of the outside air which is just sufficient to cause the necessary circulation and conduction. As an example we may quote the results for a

period in November and December 1949, when the temperature of the store air remained fairly constant around an average value of 46.6°F. About 17 tons of potatoes stored without bottom ventilation to a depth of 6 feet in a 12 feet square, close-boarded wooden bin were calculated to be producing heat at a rate of 1,120 B.Th.U./hr. The potatoes maintained an average temperature 3.3°F. warmer than that of the store air, this difference being sufficient to cause the conduction and convection necessary to remove the heat as fast as it was produced. Analysis of the results suggested that 55 per cent of the heat loss (615 B.Th.U./hr.) was due to a convective circulation of air moving into and out of the potatoes at a rate of about 100 c.f.m.*

Dimensions of the Stored Mass and Its Temperature Usually both the length and breadth of a mass of stored potatoes will be more than twice the height. When this is so the average and maximum temperatures in the mass are really determined by its height, the length and breadth affecting these temperatures comparatively little. The greater the depth of storage, the greater will be both the average and maximum temperatures. As very rough generalizations, it may be said that at normal storage temperatures the average temperature of a mass of potatoes with no bottom ventilation will exceed that of the air in the store by two-thirds of a degree Fahrenheit for every foot of height ; and that the maximum temperature among the potatoes will exceed the average temperature of the store air by 1°F. for every foot of height.

The maximum temperature in a mass of potatoes stored as a cube 12 feet × 12 feet × 12 feet with no bottom ventilation has been found to be in the centre at a point about 2 feet below the top surface. Bottom ventilation displaces the hottest point to a position nearer the top. When potatoes were stored to a depth of 6 feet, the maximum temperature was in the centre but only 6 inches below the top surface, even without bottom ventilation. In unventilated potatoes the minimum temperature is at the periphery, usually at one of the top corners, and does not greatly exceed the temperature of the store air. Bottom ventilation with cool air results in the minimum temperature being immediately above the ducts.

Forced Ventilation It seems probable that if the depth of storage does not greatly exceed 6 or 7 feet it may not normally be worth while to provide forced ventilation, or even ventilating ducts, under the potatoes, but it may be worth while if deep storage—say to 12 feet—is practised. Whether this is so depends largely upon individual circumstances. If wet, diseased or immature potatoes are stored, both ducts and provision for forced ventilation may be advisable, at least as a precautionary measure, even with shallow storage. On the other hand, enhanced ventilation may increase shrinkage losses, and if there is no particular reason to expect overheating and no intention of storing the potatoes late, it may not be considered necessary to provide either ducts or forced ventilation, even when storing to a depth of 12 feet.

If it is thought advisable to provide ducts, the closer together they are, the more uniform will be the air distribution. The widest spacing which has been found to give reasonable distribution is 6 feet between centres. The ventilating ducts should not be slatted throughout their length but should

* c.f.m. = cubic feet per minute.

be close-boarded for some distance (about 2 feet when the potatoes are stored to a depth of 12 feet) from the bin walls ; otherwise there is a tendency for the ventilating air not to pass through the stack of potatoes but to travel up the boundary between the bin wall and the potatoes, where resistance to air flow is less. Forced ventilation at a rate of 4,000 c.f.m./100 tons has been found to extract heat at a rate of about 110 B.Th.U./ton hour for every 1°F. difference in average temperature between the potatoes and the ventilating air. The effect on the temperatures in a 12-feet high stack of potatoes of continuous ventilation at a rate of 4,000 c.f.m./100 tons would be to reduce the difference between the maximum and minimum temperatures to rather less than 1°F., and the maximum temperature to about 2°F. above the average temperature of the inlet air.

Resistance to the flow of ventilating air varies with the size of potatoes, the amount of earth included and the degree of sprouting. Unsprouted ware potatoes (55 cu. feet per ton, free of earth) stored with about 20 per cent of soil offered a resistance of 0.019 inch water gauge per foot of height to ventilation at a rate of 4,000 c.f.m./100 tons. Sprouting to the extent of about 5 per cent by weight increased this resistance to 0.064 inch water gauge per foot of height.

Type of Bin In this country it is probable that if potatoes are stored in a building the whole floor space, or as much as is necessary, will be used without subdivision. As mentioned above, dimensions other than height matter little. If subdivision of the mass is desired—for example, if more than one variety is stored—suitable partitions can be constructed of bales of straw. Storage in wooden bins is common American practice and some studies of bin construction have been undertaken as being possibly of use in some circumstances.

If the potatoes are stored to a depth of 12 feet in wooden bins with no forced ventilation they remain slightly cooler (about 0.8°F. cooler in our experiments) in slatted than in closer-boarded bins because of greatly enhanced convection. Calculations from one series of measurements suggested that about 40 per cent of the cooling was by convection if potatoes were stored to a depth of 12 feet in a close-boarded bin 12 feet square. This convective cooling was increased to 70 per cent of the total, and the total cooling increased by about 25 per cent, in a slatted bin of the same size. If forced ventilation is used it is less efficient if the bins are slatted, because of the ventilating air short-circuiting the potatoes and escaping through the bin sides. The average and maximum temperatures of potatoes stored in bulk in straw bale enclosures in uninsulated corrugated iron buildings does not differ markedly from that of potatoes stored in wooden bins in buildings with the amount of insulation mentioned below.

Amount of Insulation on the Building The amount of insulation which has been found sufficient to prevent frost damage in Kent is that giving a thermal conductivity of 0.2–0.25 B.Th.U./hour sq. feet °F. temperature difference. In our experiments this was achieved by a 9-inch brick wall lined with $\frac{3}{4}$ inch wall board spaced $\frac{5}{8}$ inch from the brickwork. This degree of insulation is also effective in considerably reducing diurnal fluctuations and keeping the store fairly cool during the day in spring.

General Conclusions

1. It is possible to store healthy potatoes in any bulk likely to be desired, without danger of undue heating, provided either :
   (a) that the depth of storage does not exceed about 6 or 7 feet, or
   (b) that if the storage depth exceeds this, ventilating ducts and sufficient forced ventilation are provided. Ventilation at a rate of 4,000 c.f.m./100 tons is sufficient for all practical purposes. Ventilating ducts, even without forced ventilation, lead to some reduction in temperature.

2. Depending upon the individual circumstances, it may be thought safe to store potatoes to a depth of 12 feet without any form of bottom ventilation, but this would be unwise if it were intended to store late.

3. Deep storage possesses obvious advantages over shallow storage in the more efficient use of floor space.

4. By the use of forced ventilation during the night it is possible to maintain potatoes at an average temperature rather below the daily average (night and day) outside air temperature. Rarely are the cold spells during spring nights sufficiently cold or prolonged for greater cooling to be achieved. Since the average outside air temperature in the British Isles in spring is usually high enough for rapid sprouting to occur, this means that forced ventilation with cold night air does not provide a means of controlling sprouting in the British Isles.

5. Storage in buildings does not necessarily permit longer storage than storage in clamps. The advantages of indoor storage may be expected to lie more in the greater speed and ease of grading and the fact that this may be done under any weather conditions.

The work described in this article was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

FOOT-AND-MOUTH DISEASE RESEARCH

The Interim Report on the research in progress at the Foot-and-Mouth Disease Research Station, Pirbright, Surrey, prepared by the Agricultural Research Council, has now been published. Copies may be obtained from H. M. Stationery Office, or through any bookseller, price 6d. (including postage.)

SIR RICHARD WESTON AND THE NEW FARMING

THE STORY OF A PIONEER

NIGEL HARVEY, M.A., Q.A.L.A.S.

In the eighteenth century it was the " improving landlord " who provided the link between the average farmer and new tools and new methods. But it was Sir Richard Weston, a seventeenth century squire, who founded this tradition of agricultural leadership and the story of this professional ancestor of all the improving landlords enjoys, as the writer says, " that peculiar interest which attaches to the work of the pioneer."

THE seventeenth century was a singularly interesting period in our farming industry, for in it can be seen, as in a glass, darkly, the origins and promise of the New Farming which was later to change alike crops and stock, implements and methods, and even the very aspect of the landscape itself. This prophetic century saw, for instance, the first geological maps in our history, the first experiments in agricultural chemistry, the first general survey of farming practice. It also saw the coming of important new crops to the farmers' fields—turnips, potatoes and red clover—and the first sowing of the grasses which had hitherto been but wild and self-willed allies of the farming kingdom. Yet all these things were clues to the shape of agricultural things to come rather than general contemporary reality, a sudden but ephemeral preview of the tools which the Agricultural Revolution in the next century was to apply with such unprecedented vigour on such an unprecedented scale. In their own time their effect was negligible.

The reasons for this curious failure are numerous and interesting, but conspicuous among them was the gulf between the improver and the normal cultivator, between the men with the new tools and the preoccupied farmer immersed in the traditional routine of his steading and his fields. Indeed, there were in the seventeenth century various vague literary mutterings about the need of some system of agricultural training more thorough, more scientific than casual work and observation on the farm, of some " College of Husbandry " where young men could learn new and improved methods. But the time for these things was not yet ; formal agricultural education was still far in the future. There was a simpler and more obvious remedy at hand, one which combined practice with science and experimental with commercial farming. This was the " improving landlord," the human agency through whom the average farmer learnt of new tools and new methods, and it was men of this type who were to lead farming development in the days of George III. But Townshend, Coke, the Duke of Bedford and their various rural colleagues whose achievements fill the agricultural history of the eighteenth century, inherited as well as created a fine tradition for, among the forerunners of the New Farming in the seventeenth century was the first of their line, the professional ancestor of all the improving landlords. This was Sir Richard Weston of Sutton Court in Surrey, whose story enjoys that peculiar interest which attaches to the work of the pioneer.

Royalist and Exile Sir Richard Weston was born in the later years of Queen Elizabeth's reign, in 1591, and he came from that shrewd and active class of country gentry who had so increased and consolidated their power in Tudor times. In his case, the family owed its wealth to his great-grandfather, " a wild courtier and gallant soldier " in the time of Henry VIII, who had thoughtfully married an heiress and thus acquired a fortune which somehow survived his execution when he was implicated in an obscure

political plot. The son of this Weston not unnaturally preferred the quieter life of a country squire in his home county of Surrey, where he was twice appointed Sheriff, and in due course the estate descended to his son and then, in 1613, to his grandson, our Sir Richard.

Little is known of his early life and there is apparently no foundation for the story that he was educated in the Low Countries. So we can imagine him peacefully administering and improving his estates until the troubled time of the Civil Wars, when disaster came to him. For he was a Royalist, one of the defeated party, and in 1644, when the King's cause was clearly doomed, he found it prudent to abandon his lands and take refuge in Holland.

Yet this observant and active-minded man contrived to turn even defeat and exile to advantage. For at that time Holland was one of the most advanced agricultural areas in the world, and there was much for him to see and to learn ; so he wisely fell into the habit of taking long country walks, " farming over the hedge " as he went and, in his own picturesque words, " expostulating the business of farming with the boors "—that is, discussing farming matters with the local peasantry. He noticed, for instance, that while turnips in Holland were still, as in England, primarily a vegetable for human consumption, they could be fed successfully to stock ; " the boors, what they do not eat themselves, they give to their cattle. They will feed oxen as well as hay and oats". He also studied the cultivation of red clover, at that time, it appears, unknown in England, and he decided that the best method of sowing it was by paring, burning and liming the soil to make it clean and sweet, to secure a good seedbed by ploughing and harrowing, and then to sow the seed (10 lb. to the acre) in late March or early April, five years being a normal time to leave it down.

He also interested himself in canals and locks, for the communications of Flanders, and consequently the scope of the farmer's marketing, were far more advanced than those of England. Weston envied, too, the fecundity of the Dutch sheep and the superiority of Spanish wool and regretted the backwardness of his own countrymen in the breeding of stock. And then fortune gave him a chance of trying his new ideas and crops ; he made his peace with the new Government of Cromwell and returned home, apparently in 1649, to his estate.

Return to Surrey So he set himself to improve his property, boasting that he used " both fire and water " in the process—fire for burning and clearing the land, water for irrigating his meadows. He also introduced into Surrey "the grass called 'Nonesuch'," the modern trefoil, and a contemporary, Adolphus Speed, himself a farming writer and an early champion of turnips, remarked on "the extraordinary hay which his meadows watered by his new river did yield". But his most spectacular effort was his attempt to canalize the River Wey and, despite legal and other difficulties, he succeeded in executing ten miles of this considerable scheme—sometimes two hundred men were employed on it—before his death. Incidentally, the cut he made was in commercial use within living memory.

His greatest achievement, however, lay in the new crops he either introduced or championed. Of these, the turnip and red clover were the most important, though he was in his own day little more than a voice crying in the wilderness, and over a century was to pass before the men of the New Farming were to put his ideas into general practice. He himself sold some of his turnips as vegetables, four or five in a bunch for a penny, but others he kept for stock, first carefully (if unnecessarily) washing them and mashing

them, along with their tops. Indeed, he claimed that he could make the very considerable profit of £8 an acre from turnips and £10 an acre from red clover, but the most lucrative crop, he thought, was flax. This figured prominently in the rotation he proposed : flax, turnips, oats, and a four-year clover ley, the seeds of the latter being harrowed in with bushes. Thus did the revolutionary principle of sowing grass or clover seeds as part of an arable rotation make its appearance in this country and, significantly, it was about this time that there occurs the first reference to the commercial availability of red clover seed which was on sale " at the shop of James Long, at The Barge on Billingsgate". But many, many years were to pass before the basic four-course shift, which Weston's rotation foreshadowed, became general practice.

Weston was, however, a landlord as well as a farmer, and his interests extended beyond the immediate cultivation of land. He felt, for instance, that tenants should be encouraged to improve their farms by greater security of tenure and by the right to receive compensation at outgoing for any improvements they had made during their period of occupation ; he quoted a Flemish custom, apparently unknown in England at that time, of twenty-one year leases, at the end of which the tenant was compensated by the owner for any improvements he left, the amount being settled by " four indifferent persons, whereof two are chosen by the one party and two by the other". Like many men of his age, too, Weston was much concerned at the destruction of our woodlands, which compelled us to import planks from Norway and plough-staves from Prussia. Not that he was against reclamation ; for he instances land at Tonbridge which yielded far more under crops than under timber, and he had himself converted some of St. Leonard's Forest to tillage land, while he disliked the " ill tenures " which forbade tenants to clear scrub or poor woodland. But he wanted to see more planting by owners, and he particularly praised one Essex squire who had turned some of his damper meadows into a thriving willow-ground. He also condemned the extravagant use of timber as fuel for smelting iron, and he welcomed, prophetically, a recent patent for smelting iron with sea-coals. Thus he looked forward, on the one hand, to the coming of tenant-right and the Agricultural Holdings Acts and, on the other, to the champions of forestry down the centuries to the Forestry Commission of today.

In less detailed fashion, he lamented the lack not merely of agricultural education but even of good works of agricultural reference—though he did not go as far as the famous Bacon who, half a century before, had lit a fire in his courtyard and burnt a library of farming books he had been at some pains to collect, saying that none contained any information of practical use to the farmer. But Weston hoped that the literary world would produce some ambitious, thorough and reliable work to summarize and record the experiences of progressive farmers. All this, of course, is rather general, but did not Weston's ideas adumbrate the agricultural societies and technical books, the farming press and the advisory services and the various other sources of information which we today take for granted ?

Weston died in 1652, and his memory is preserved in a book he wrote called *A Discourse of Husbandry in Brabant and Flanders*, though the manuscript was piratically printed in 1650 by Samuel Hartlib with an introduction to " The Rt. Hon. the Council of State " of the Republican Government. Weston, the royalist, could hardly have approved this flattery by his old enemies, yet Hartlib was merely doing what Weston, the improving landlord, had so zealously urged, in making available to the generality of farmers the experiences of the pioneer.

GAME BIRDS AND AGRICULTURE

F. HOWARD LANCUM, M.B.E., F.L.S.

Are British game birds a menace to agriculture? While the evidence shows that they will often take grain or other cultivated crops, the writer suggests that the amount they consume is insignificant compared with the good they do in other directions.

IT seems doubtful whether, in this country, game birds will ever again be of the importance to agriculture that they have been in the past. While one may hope that they will remain with us in sufficient numbers, if I read the signs aright game preserving on the pre-war scale has gone for ever, and from some points of view that is greatly to be regretted. As I see it, the future, such as it is, is for the man with the small shoot, while the large estate shoots of the old days will become fewer and fewer.

Before discussing the game birds themselves and their relationship to agriculture, I ought, I think, to say something about the gamekeeper in his human relationship to the farmer. In the palmy days of game preserving, farmer and keeper were, as a rule, on good terms with one another; and for good reasons. Each could and did help the other in many ways. The keeper could tip off the farmer about straying cattle, or about a gap in a hedge which the farmer himself may not have noticed ; he could render first and necessarily speedy aid to a sheep on its back in a ditch, could arrange for the destruction of a fox that had been raiding the farmer's fowls, and so on. On his part, the farmer could inform the keeper of a previously unsuspected pheasant's nest discovered by one of the farm workers ; could, with a little care when mowing, save a sitting partridge from decapitation and her eggs from destruction ; could warn the keeper of the activities of a poacher which may have come to his own notice but escaped the keeper's. In short, the combination of farmer and keeper was a powerful and mutually helpful one, and in the vast majority of instances that I have known both farmer and keeper realized that very well and took full advantage of it. On the few occasions when farmer and keeper were at odds, the interests of both suffered as a consequence.

A good deal of nonsense has been talked and written about the gamekeeper and the effects of his activities on wild bird life. For the old-style keeper (and he *could* be found, here and there) who on principle killed every bird that had a hooked bill, I have no use at all. He was a nuisance, and a serious one, but he is certainly not typical of the keepers of today nor even of the keepers of the between-wars period. The modern keeper, like the best of the old-timers, is a pretty good naturalist ; it would be surprising if he were not. The detractors of the keeper and of game preserving generally seem not to be aware that the average game covert of, say, the 1930s, was in effect a small bird sanctuary ; for not only were human trespassers excluded from it but, in the main, those larger birds which the keeper kept down in the interests of his employer's game were those inimical to small wild bird life. One has only to consider the present abundance of the crows and the dangers of their abnormal increase to realize what sterling work the gamekeeper did, and to realize, also, how grievously he is being missed today in many parts of the country.

Pheasants Now about game birds, and first of all the pheasant. In writing of this bird, many find it expedient to do so with circumspection. There was once a famous politician and statesman who, in an unguarded

moment, delivered himself of a pronouncement regarding the habits and character of the pheasant. From then on, every cartoon of him bore, somewhere in the picture, a pheasant and a mangold, and the bird and the root stuck to him for the rest of his public life. As I am neither famous nor a politician, I have less to worry about, which perhaps is as well, since about the pheasant I have formed opinions that are at variance with those of certain other naturalists.

In the first place, I do not believe that the pheasant is anything like the pest that it is sometimes said to be. In fact, I believe that in reasonable numbers it does much more good than harm. Certainly it eats some grain and other agricultural produce, but it also destroys a good many agricultural pests—and in considerable numbers. Where pheasants are concentrated near ripe, ripening or stooked corn, they are capable of harm, but at the present time I do not think that the possibility of heavy concentrations of pheasants need weigh very heavily on the farmer's mind.

It seems not to be generally realized that of all our birds the pheasant is the arch-destroyer of wireworms ; it is a powerful scratcher and knows just where to look for these pests. I once took 300 wireworms from a single dead pheasant, and from another a friend of mine took nearly double that number. By reason of its exceptional scratching ability—which, like its ancestry, it shares with the common fowl—the pheasant is especially well adapted for dealing with these pests. Anybody who cares to watch the bird can see for himself that it spends a good deal of its time scratching for food. Also, the pheasant shows quite remarkable agility in catching crane-flies and other winged pests of farm land. On a damp morning when small slugs are on the grasses and other vegetation, it is as good as a runner duck—and that is high praise. I find that most farmers like to see a few pheasants about their fields.

This is not the occasion to discuss the ethics of preserving pheasants for shooting, but it is at least clear that the opponents of this pastime must look, for their arguments against it, elsewhere than in the direction of the pheasant's alleged harmfulness. In the unhappy event of the pheasant becoming lost to us as a British species—and, lacking a certain amount of preservation and protection lost it would assuredly be—the countryside would be the poorer for the absence of a strikingly handsome and at the same time useful bird.

Partridges Without any hesitation I would rate the common partridge, also, as a bird beneficial to agriculture. It takes some grain, clover and other cultivated crops, but it also eats large quantities of weed seeds as well as injurious insects and slugs. I have examined the food contents of a great many dead partridges, but have never found what I considered to be a balance on the wrong side.

At the present time it is to be feared not only that there are too few partridges in the country as a whole, but that their numbers are still declining. These birds are more vulnerable than pheasants, and unfortunately can never be accorded quite the same degree of protection that can be given to pheasants. Added to these things, poaching has made great inroads on the partridge stock in many parts. To what extent this is the case is evidenced by the suggestion that, in Cornwall, the partridge should be put on the totally protected list for a period. It is true that Cornwall was never a really good partridge county, but the situation there is a pointer ; there is reason to believe that the stock in other counties is getting dangerously low.

It will be remembered, also, that between the two world wars the partridge became so scarce in Ireland that its extinction appeared to be by no means unlikely, and drastic measures were considered necessary. Poaching, of course, is not the only factor in the partridge decline in Cornwall, any more than it was in Ireland, but I am convinced that it is the principal one, and poaching, in these days of food shortage and fancy prices, is on a much more serious scale than it was in years gone by and is much harder to prevent. Here, once more, we have cause to regret the comparative scarcity of keepers.

The feeding habits of the red-legged (or "French") partridge are much the same as those of the common partridge. I would say, however, that it seems to be rather more partial to grain, although I would not care to be dogmatic about it. So far as I can discover, little if any serious work has been done on the feeding habits of this species, and my own opportunities for study have been too few to be worth anything as evidence.

Grouse The red grouse is a bird which most farmers in this country will never see alive unless they take a journey of considerable length and duration, and they will therefore not need to bother about it. Even on farms bordering such well-known grouse areas as the Yorkshire moors, this bird does little harm to agriculture. Something like three-quarters of its food consists of heather, mixed with wild seeds and berries, insects and slugs. At harvest time, parties of red grouse come down from the moors and visit the neighbouring farms, where they take a certain amount of grain from stubble and stook, but it is not possible to regard this species as a serious enemy of the farmer.

There is one particular problem concerning the red grouse that has always puzzled me. On Dartmoor, a district I know as well as and, I think, better than most people, various attempts have been made to introduce and acclimatize red grouse. Here, one would think, are conditions and vegetation comparable with those on the Yorkshire moors, affording the same facilities for feeding and breeding in an area where human interference is at a minimum. Yet, while in any year since I was a boy I could find a few birds on some parts of the Moor, they have never really thrived or firmly established themselves. Last September, in a whole day's tramp across the Moor, I put up three birds in all ; that is about the maximum number that I have seen on any one day for many years past. Much the same thing applies to the Black Grouse. In spite of statements to the contrary, there are still a few of these birds on Dartmoor, but I should never be surprised to hear that they had finally disappeared. Except for parts of the North, so far as England is concerned, the black grouse might as well be omitted from this article. Of the bird's feeding habits in Scotland, I know little, but I am told by Scottish friends that while at times it does more damage than the red grouse to crops, it, too, can hardly be regarded as a serious proposition.

No Menace to Agriculture To sum up : one is, I think, on safe ground in asserting that the game birds of this country are not, and never will be, a serious menace to agriculture ; to the contrary, most of them are beneficial on balance. It is conceivable, but hardly likely, that pheasants could be present in some given area in such numbers as to cause appreciable loss of grain. As for the partridges, I cannot see either species as a pest, whatever its numbers may reach, and the same holds good for both the red and the black grouse.

FARM TRACTOR CENSUS

A CENSUS of farm machinery taken in January 1952 by the Agricultural Departments in the United Kingdom, shows that the number of tractors then in use in each country was as follows :

Table 1
Estimated Numbers in Use

Description	England	Wales	Scotland	Northern Ireland	United Kingdom
Agricultural Tractors of 10 h.p. and over					
Tracklayers	14,490	1,120	1,590	50	17,250
Wheeled	240,380	27,010	37,890	19,540	324,820
Total	**254,870**	**28,130**	**39,480**	**19,590**	**342,070**
Horticultural Tractors of under 10 h.p.					
Tracklayers	3,790	270	300	30	4,390
Wheeled	36,060	1,840	2,350	480	40,730
Total	**39,850**	**2,110**	**2,650**	**510**	**45,120**

Interest has been shown in the number of tractors which use the different kinds of fuel—diesel, petrol and vaporizing oil. It is possible to make a fairly reasonable estimate of the fuel types by analysing tractor supplies in the preceding years—production for the home market and imports. It has to be assumed that tractors of all fuel types have been scrapped at the same rate, and no attempt has been made to assess the extent to which petrol tractors have been converted to burn P.V.O.

Table 2
Fuel Types

Description	Diesel	Petrol	P.V.O.	Total
Tracklayers } 10 h.p. and over	8,900	4,070	4,280	17,250
Wheeled }	12,450	53,480	258,890	324,820
Total Agricultural Tractors	**21,350**	**57,550**	**263,170**	**342,070**
Tracklayers } under 10 h.p.	—	4,390	—	4,390
Wheeled }	—	40,730	—	40,730
Total Horticultural Tractors	—	**45,120**	—	**45,120**

In Northern Ireland the figures for agricultural wheeled tractors were collected on a fuel type basis : diesel—120 ; petrol—6,580 ; P.V.O—12,840; the proportion of petrol-burning tractors is very much larger than in the rest of the United Kingdom.

FARMING AFFAIRS

Bred Strains for Better Grass and Clover

Time was when grass was just—grass. Today it has come to the full stature of a crop—and a very important crop at that. It follows from this, therefore, that increasing attention has and is being paid to the breeding of better herbage to secure those high quality grass-legume swards around which pivots the modern system of alternate husbandry. The improvement of herbage crops by breeding has as its main objective the provision of better strains, both for hay and grazing. The cultivated species of grasses and clovers are mainly cross-pollinated. As a result, the breeding operations, as well as the production and multiplication of seed of the improved strains on a commercial scale, give rise to greater technical difficulties than is the case with self-pollinated crops, such as wheat, barley and oats. In addition, grasses and clovers are very largely self-sterile, so special methods had to be devised before promising plants could be subjected to the crossing and progeny-testing operations necessary to determine their relative value for breeding purposes.

When the Welsh Plant Breeding Station at Aberystwyth began its researches on the improvement of forage crops, a great deal of pioneer work had to be undertaken before the practical breeding operations could be developed on sound scientific lines. These fundamental researches have resulted in the successful production in recent years of several pedigree strains of each of the more important grasses and clovers. Today these have largely displaced the stemmy, short-lived grasses which formerly were used for the seeding down of arable land to short- or long-rotation leys.

In the past farmers were reluctant to plough up good grassland for arable cropping because the seeds then available failed to provide a good, persistent sward; nowadays it is possible, by the use of these bred strains, along with good manuring and management, to establish good grazing swards on almost all classes of soils.

These new strains have been selected for high tillering and leafiness, and as leaf is of higher feeding value than stem, they provide herbage of high quality and good feeding value. True, the cost per pound of pedigree seed is higher, but this is offset by the fact that seeding rate is lower because these strains tiller better and remain productive longer.

Strains suitable for short- as well as for long-term leys have now been produced. Of these, special mention should be made of the more recently introduced S.24 perennial ryegrass and S.22 Italian ryegrass.

No less striking than the success of these new strains in producing good swards on lowland farms has been the remarkable success of certain strains for the improvement of hill grazings by ploughing and direct reseeding. Under these conditions their persistency and continued productivity, coupled with good management, have been the means of increasing the ewe-carrying capacity of the hill pastures, raising the lambing percentage, and adding weight and quality to the lambs.

The marked improvement in herbage plants accomplished by the grass and clover breeders represents one of the major present-day contributions of scientific research to the solution of the problem of increasing home food production, reducing costs and diminishing the need for purchasing imported feedingstuffs. The growing of these new strains of grasses and clovers for

seed is a new enterprise for the British farmer, and Seed Growers' Associations and supervised field crop inspection schemes have been instituted to ensure that high quality seed is available in adequate supply.

E. T. Jones.

Farming Cameo : 22. Tweedside, Glendale and Belford, Northumberland This district lies in the north-east corner of Northumberland, separated from Berwickshire by the River Tweed. It is essentially rural and the main towns of Wooler and Berwick-on-Tweed have practically no industry other than agriculture. Wooler, a small market town lying at the foot of the Cheviots, is one of the biggest store sheep centres in the north of England. Berwick, though no longer a cattle market, is reputed to have the second largest corn market in England.

The main topographical features are the Cheviot Hills in the west, a strip of moorland 400–800 feet high running up the centre, a lowland area between the two, and a flat, narrow coastal plain. The rainfall ranges from 25 inches on the coast around Bamburgh, to over 30 inches in the Cheviot Hills. The total area of agricultural land is 220,000 acres, of which some 73,600 is rough grazing. Two-thirds of the remainder is under grass. The farms are large; 25 per cent are over 500 acres and almost half of them exceed 100 acres. Traditionally, this is a livestock area, carrying, at present, 39,000 cattle and 226,000 sheep. Pigs and poultry are relatively unimportant, although within recent years their numbers have increased markedly. The few dairy herds are practically all situated around Berwick.

Four distinct farming types can be seen in this area. Firstly, there is the coastal strip, or Belford district, which is primarily engaged in the grass fattening of cattle and sheep. Although, nowadays, only about 47 per cent of the land is under permanent grass, compared with some 80 per cent before the war, it is still one of the best grass-feeding districts in the north of England, the permanent grass being of a high quality *lolium-agrostis* type. The productivity of the grassland is maintained by periodic dressings of basic slag. The soils, derived from boulder clay, are heavy on the whole and, in some cases, difficult to cultivate. Black polled Irish cattle are generally favoured, although many Irish Herefords are purchased at Alnwick during the spring and summer. The most forward are graded the same autumn, but large numbers are wintered on oat straw and swedes and are graded off the grass in the following June or July.

The Glendale district, lying in a valley west of the Cheviots, could aptly be described as "sheep and barley land". The soil is light and gravelly, except for some alluvium near the river beds. Blowing occurs on a few farms in the spring, and generally speaking the land will not hold grass for longer than three years. A six-course rotation including two corn and one root crop, is adopted, and fertility is maintained by a ley, sheep folding and the application of farmyard manure. Breeding herds are kept on farms which have hill or rough grazing. The blue or black Irish cow is the most popular and is mated with the Angus bull. Calving begins in January and the calves are usually sold as stores at the October sales.

On Tweedside, in the north, the farming is arable with livestock. The soil is a rich loam, alluvial in character, and over 60 per cent of the total acreage, excluding rough grazing, is under direct crop. Barley is the most important cereal, the acreage devoted to this crop being roughly equal to the combined acreages of wheat and oats. The rootbreak in the rotation consists of potatoes, swedes, yellow turnips, mangolds or sugar beet. There is a high

rate of stocking of beef cattle and sheep, and additional home-bred lambs are brought in to be fattened on sugar beet tops and swedes.

With the exception of some Cheviot flocks on the more marginal farms, practically all the ewes in these three areas are Halfbreds (Border Leicester × Cheviot). Suffolk and Oxford tups are used almost exclusively. The lambs are sold fat off the grass or the rootbreak, except for those on the harder land nearer the hills which are sold as stores in August.

The final farming type is found in the Cheviot Hills which lie between 1,000 and 2,000 feet, the highest point being "The Cheviot" (2,677 feet). The hill farms are large, many having little or no in-bye land. They mostly carry a good mixed hill herbage, including some heather, but bracken, which has spread rapidly during the last half century, is a serious problem. Self-contained flocks of Cheviots and the Scotch Blackface are kept, the Cheviots being on the better land. Many hirsels have changed from the Cheviot to the Blackface during the last few decades.

W. J. Graham,
District Advisory Officer

The Minister's Liaison Officers In the interests of greater food production the Minister of Agriculture has, as foreshadowed in his statement in the House of Commons on July 31, now appointed thirteen liaison officers to forge a closer personal link between him and county and district committees. "Under prevailing conditions," he said, "it is impossible for me and my two Parliamentary Secretaries to visit many county committees in the course of the year and I have, therefore, decided to revive the system of part-time liaison officers that was so successful during the war years. I am glad to say that a number of prominent men in the agricultural field have very kindly agreed to act as my personal representatives in this important liaison work."

The Liaison Officer will thus be the Minister's "Personal Ambassador" to a group of counties. He will have the task of interpreting the Government's policy to the County Agricultural Executive Committees and to other agricultural organizations in his area. At the same time he will be able to keep the Minister informed of agricultural developments in his group of counties and, in particular, about anything which may be hindering the new Food Production Drive.

This new system of personal Liaison Officers will be complementary to the efficient technical and administrative machinery that has been set up since the war with the establishment of the National Agricultural Advisory Service and the Agricultural Land Service and has already proved a valuable asset in promoting increased food production.

The Liaison Officers appointed and the areas in which they will operate are as follows:

Name	*Province*	*Counties*
Professor R. W. Wheldon, F.R.S.E., D.Sc.	Northern	Cumberland, Durham, Northumberland, Westmorland
Major Fitzherbert Brockholes, C.B.E., M.C., J.P.	Yorks and Lancs	Lancashire, Yorks (E.R.), Yorks (N.R.), Yorks (W.R.)
Mr. Henry Overman	East Midland	Derbyshire, Leicestershire, Lincolnshire (Kesteven), Lincolnshire (Lindsey), Northamptonshire, Nottinghamshire, Rutland

Sir Edward Foster, C.B.E., J.P.	West Midland ..	Cheshire, Herefordshire, Shropshire, Staffordshire, Warwickshire, Worcestershire
Major Sir Richard Proby, Bt., M.C. ..	Eastern (part) ..	Hunts and Soke of Peterborough Lincolnshire (Holland), Bedfordshire, Isle of Ely, Hertfordshire, Cambridgeshire
Colonel Sir Robert Gooch, Bt., D.S.O., D.L., J.P.	Eastern (part) ..	East Suffolk, West Suffolk, Essex, Norfolk
Colonel S. E. Ashton, O.B.E. ..	South-Eastern (part)	Berkshire, Buckinghamshire, Oxfordshire, Middlesex, Hampshire, Isle of Wight
Mr. Dunstan Skilbeck, M.A. ..	South-Eastern (part)	Kent, Surrey, East Sussex, West Sussex
Mr. Richard Trumper, C.B.E. ..	South-Western (part)	Cornwall, Devon, Dorset
Earl Waldegrave, J.P.	South-Western (part)	Somerset, Gloucestershire, Wiltshire
Mr. E. G. E. Griffiths	Wales (part) ..	Denbigh, Flint, Caernarvon, Anglesey, Montgomery
Capt. N. G. Garnons-Williams	Wales (part) ..	Radnor, Brecon, Monmouth, Glamorgan, Carmarthen
Mr. R. Phillips, M.Sc., A.R.I.C.	Wales (part) ..	Merioneth, Cardigan, Pembroke

The Problem of Potato Harvesting

Lack of labour to cope with the harvesting of our present acreage of potatoes is a serious problem in many parts of the country, especially where sugar beet lifting competes for manpower. With this in mind, the British Society of Research in Agricultural Engineering have made a preliminary study* of the requirements in terms of men and machines for different methods of harvesting potatoes on the fen and silt soils of East Anglia, which should be of interest to many growers.

In all, nine farms were selected and ten methods of harvesting, ranging from the elaborate harvester to elevator diggers, spinners and a horse-drawn potato plough, were examined, the information being gathered from a series of time and motion studies of the machines, transport and labour, and from measurements of output and efficiency.

The results of the inquiry showed that even in this carefully selected area the rate of output per man and running costs were much more dependent on the skill of the team than on the type of machine chosen. This is instanced particularly by the fact that a good picking team, using the simple horse-drawn potato plough, was able to achieve approximately the same output per man as the far more complex and costly potato harvester. Similarly, although the two single-row diggers worked for approximately the same length of day, the output of the one was twice that of the other, due entirely to the efficient working of the team with the former.

Although skill had such a big effect on the performance of all the machines, the type of implement used made a great deal of difference in lightening the work of the pickers. Thus, with the harvester, the operators are carried on the machine and have only to pick off the stones and rubbish. With such

* *Methods of Harvesting Potatoes : A Preliminary Study.* Obtainable from the National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds, or the Scottish Machinery Testing Station, Howden, Mid-Calder, Midlothian, price 3s. including postage.

elaborate machines, the number of operators may be reduced to give an appreciable improvement in output per man. Even on the simpler harvesters where there is no mechanical provision for separation of stone and haulms, sorting is easier than picking behind a spinner or plough. Particularly, then, in the case of the harvester, if the job can be lightened, longer hours can be worked and a bigger acreage covered. Moreover, a less skilled and agile team can be employed without reducing output.

Apart from considerations of labour and ease of picking, the other important problem facing the potato grower is that of working under difficult conditions such as may occur late in the season. Here, the horse-drawn plough is probably supreme, but even so the efficiency of the modern potato harvesters is such, that, at least on light or stone-free land, they are able to maintain almost as long a working season. The two-row digger, which provides a cheaper method of potato picking, is also capable of a fast rate of work and is therefore able to make full use of short periods of fine weather, but unfortunately to do this it requires a relatively large number of workers.

AGRICULTURAL INDEX NUMBERS AND PRICES

MONTHLY INDEX NUMBERS AND PRICES OF AGRICULTURAL PRODUCTS

INCLUDING EXCHEQUER PAYMENTS (UNCORRECTED FOR SEASONAL VARIATION)

BASE 1927–29=100

	Unit	Prices used for June Index	1952			1951		
			Apl.	May	June	Apl.	May	June
All Products ..	—	—	264*	242*	243*	251	231	235
Cereals and Farm Crops	—	—	280	280	283	270	278	285
Livestock and Livestock Products	—	—	259*	230*	230*	245	214	217
		s. d.						
Wheat	cwt.	30 10	294	295	298	284	287	290
Barley	,,	27 11	300	270	254	336	339	328
Oats	,,	26 2	300	287	283	277	294	298
Potatoes	ton	293 6	263	278	292	236	248	265
Hay	—	—	233	232	225	254	258	257
Fat cattle ..	Live cwt.	135 3	281	285	275	257	258	248
Fat cows ..	,,	78 4	217	217	223	207	207	215
Fat sheep ..	lb. d.w.	2 10¼	275	275	269	263	263	251
Fat ewes ..	,,	1 9¼	276	270	261	261	255	233
Bacon pigs	Score	54 11*	360	360	360*	346	346	346
Pork pigs ..	(20 lb.)	51 9	306	306	306	296	296	296
Sows	d.w.	28 6	250	248	248	235	235	235
Milk	Gallon	2 2.2*	263*	202*	202*	245	189	188
Butter	12 lb.	30 0	143	143	143	114	125	143
Poultry	—	—	277	272	270	318	299	272
Eggs	120	40 0	197	215	220	193	193	229
Store Stock†		£ s. d.						
Dairy cows ..	Head	53 0 0	194	194	196	177	179	181
Store cattle ..	,,	38 19 0	247	265	268	222	231	232
Store sheep ..	,,	7 17 6	303	318	291	268	280	286
Store pigs ..	,,	8 11 6	415	449	455	438	450	461

* Provisional

† Not included in general index

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the June 1952 *issue of* AGRICULTURE (*p.* 147), *the undermentioned publications have been issued.*

MAJOR PUBLICATIONS. Copies are obtainable, at the prices quoted, from the Sales Offices of H.M. Stationery Office or through any bookseller.

Bulletins

No. 8	Poultry on the General Farm (*Revised*)	1s. 9d. (1s. 10½d. by post)
No. 36	Manures and Fertilizers (*Revised*)	3s. 6d. (3s. 8d. by post)
No. 51	Narcissus Pests (*Revised*)	2s. 6d. (2s. 7½d. by post)
No. 55	Outdoor Salad Crops (*Revised*)	2s. 6d. (2s. 7½d. by post)
No. 92	Chrysanthemums (*Revised*)	3s. (3s. 1½d. by post)
No. 148	Incubation and Hatchery Practice (*New*)	3s. (3s. 1½d. by post)
No. 155	Estate Yards (*New*)	3s. (3s. 1½d. by post)

Other Publications

American Agriculture : Its Background and Lessons (*New*)	2s. 6d. (2s. 8d. by post)
Grain Drying and Storage in Great Britain : Report of Working Party (*New*)	1s. 6d. (1s. 7½d. by post)
•Borth Bog Investigation (*New*)	2s. 6d. (2s. 7½d. by post)
†Lakenheath Fen Investigation (*New*)	2s. (2s. 1½d. by post)
†Over and Bare Fen Investigation (*New*)	1s. 6d. (1s. 7½d. by post)
†Swaffham Prior and Burwell Fen Investigation (*New*)	1s. 6d. (1s. 7½d. by post)
†Yetminster Farm Boundary Report (*New*)	10s. 6d. (10s. 8d. by post)

• Welsh Agricultural Land Sub-Commission Report

† Agricultural Land Commission Reports

LEAFLETS Up to six single copies of Advisory and Animal Health Leaflets may be obtained free on application to the Ministry (Publications), 36–38 Chester Terrace, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from a Sales Office of H.M. Stationery Office.

Advisory Leaflets

No. 18 Cabbage Root Fly (*Revised*)
No. 129 The Loganberry (*Revised*)
No. 164 Raspberry Beetle (*Revised*)
No. 190 Control of Bracken (*Revised*)
No. 245 Apple and Pear Scab (*Revised*)
No. 280 Ragwort (*Revised*)
No. 319 Soil Sterilization (*Revised*)
No. 386 Egg Production in Poultry Yards (*New*)
No. 387 Laying Cages (*New*)
No. 390 Reseeding of Grassland (*New*)
No. 394 Dried Grass and Dried Lucerne (*New*)
No. 395 Hay : Its Making and Feeding (*New*)
No. 401 Windrow Harvesting (*New*)

Other Leaflets

Home Freezing of Fruit and Vegetables 2d. (3½d. by post)

FREE ISSUES Obtainable only from the Ministry (Publications), 36–38 Chester Terrace, Regent's Park, London, N.W.1.

Farm Machinery Leaflets

No. 8 Corn Drills (*New*)
No. 14 Field Crop Sprayers (*New*)

Growmore Leaflets

No. 49 Herbage Seed Mixtures, 1952 (*Revised*)
No. 64 Rations for Livestock (Summer Period, 1952)
No. 104 Peas and Beans in the Garden (*New*)
No. 105 Cabbages and Related Crops in the Garden (*New*)

Other Leaflets

Full-time Agricultural Education in England and Wales (A.E. 52/53) (*Revised*)
Economy of Steel in Farm Buildings (*New*)
Economy of Steel in Fencing (*New*)

BOOK REVIEWS

Fundamentals of Soil Science (2nd Edition). C. E. MILLAR and L. M. TURK. Chapman and Hall. 44s.

The fact that the authors of this well-known text-book, both in turn head of the department of soils at Michigan State College, have been able to look at their subject as teachers, research and advisory workers, gives the publication a special value. Dr. Turk has a particular interest in soil microbiology. The book follows the conventional lines, with chapters on soil minerals and the process of soil development, organic matter, and soil water relationships. But much more is covered than soil science in its narrowest sense ; there is always a close connection between theory and management and accordingly the chapter on soil reaction is followed by one on lime in which such practical aspects as the kinds of liming materials and how to use them are not overlooked. Likewise the chapters on soil organisms and soil organic matter lead to a lengthy treatise on green manures and animal manures ; here again a good deal of practical material is included. On the same principle the nutrient requirements of plants leads to a chapter on fertilizers and fertilizer materials.

Some elementary knowledge of chemistry and biology is required to follow parts of the book, but the authors make no attempt to lead their readers into regions of controversy, although in many fields they indicate that the last word has not yet been said. The book is easy to read and written in a text-book style with a list of objectives and questions at the beginning of each chapter. To some readers the questions may be unnecessary or even distracting, since they are usually the sectional headings put in question form. There is some repetition arising out of the association of the more scientific and the more practical chapters, but from the teaching point of view this is probably an advantage in emphasizing important points.

The book can be read with advantage by British students wishing to study the elements of soil science from another angle, particularly those who are interested in soils and farming systems different from those found in the temperate parts of N.W. Europe.

H.V.G.

Farm Mechanisation Hand Book (2nd Edition). T. HAMMOND CRADOCK. Temple Press. 10s. 6d.

Nowhere is a stitch-in-time, prevention-better-than-cure frame of mind likely to pay bigger dividends than on the mechanized farm—even on the small or medium farm with a moderate range of the traditional tools of the food-grower's craft.

This completely rewritten edition of the Hand Book, first published four years ago, gives trouble-prevention an appropriate priority, although the cures take far more space just as in practice simple routine precaution takes far less time than putting right a breakdown.

There is a real down-to-earth flavour about the Hand Book and it professes with truth to be compiled for the man on the job. He is told how, systematically, to set about discovering why a machine has ceased to work or why it has become sluggish.

Like the medical first-aid book, this Farm Mechanisation Hand Book will give its possessor a sense of comfort and security. He can study the preventive technique at leisure and at the first sign of indisposition he can readily refer to the appropriate chapter ; he would be very unfortunate if he fails to get at least a good clue to the cause of the complaint. The early diagnosis of trouble is in fact stressed as one of the pivots of efficient maintenance and operation of farm machinery. To be able to diagnose correctly is, nine times out of ten, to know at once whether curative treatment can be given by the owner in the workshop or by the general practitioner in the village or whether the "patient" must go to a specialist—the manufacturer's agent or the factory where it first saw the light.

The selection and use of tools for maintenance in the field, the layout of the farm workshop and the pieces of equipment it should house, and the points to watch in dismantling and reassembling machines are all given due attention.

The tractor is accorded space in keeping with its importance and its intricacies : 200 pages and a score of chapters are needed to describe the different ailments that can develop in one part or another of its "anatomy" ; symptoms are clearly described and the prescriptions for medicine or treatment needed to restore health are given in good plain terms.

Less, but adequate, attention is given to other members of the mechanical family—the mowers, the binders, the combines and the balers. Photographs and line drawings are printed wherever the text can be made clearer by illustration.

Here is a book which is full of meat for the novice and the oldest hand could not with truth say he knows it all. The farmer who presents copies of this book to his men will make a good investment—the men could hardly take such artfulness amiss.

R.S.M.

BOOK REVIEWS

Principles of Fruit Preservation (3rd Edition). T. N. MORRIS. Chapman and Hall. 21s.

For some years Morris's *Principles of Fruit Preservation* has been the standard text-book for those requiring the current scientific views on the formation of the pectin gel in jam-making, and on the canning and dehydration of fruit. This revised edition will, therefore, be very welcome both to scientists and others working on these problems. It is compact, well written and well printed.

The complex problem of the pectin-sugar-acid gel is very clearly presented, the text having been considerably revised in the second and current editions. This is followed by a chapter on the manufacture of jams and jellies.

The section on fruit canning includes an account of the general process, sugar tables, heat-penetration rates and thermal-death-time curves for micro-organisms in canned food, illustrating the variation in processing times required. Spoilage connected with can corrosion is covered excellently, but microbiological spoilage is only briefly mentioned.

The dehydration of fruit is treated in considerable detail and shorter references are made to refrigerated fruits, candied and crystallized fruits, fruit juices and syrup, and fruit bottling. An introduction to the subject of composition of fruits, with chapters on discoloration and vitamins in preserved fruits complete the book.

With so much valuable information in some 200 pages, criticisms are of a minor nature, but one or two of the tables on minimum fruit or sugar contents in the jams and canned fruit sections need revision, and references to more recently published works on fruit syrups and the composition of fruits would have been welcome.

B.A.C.

British Standards Yearbook, 1952. British Standards Institution, 24, Victoria Street, S.W.1. 7s. 6d.

It may not be generally known that there are now available some fifty British Standards and half a dozen Codes of Practice of use and interest to all concerned with the provision of buildings and other fixed equipment for farms. Three of these—namely, No. 1754 " All Steel Hay Barns with Curved Roofs ", No. 1612 " Timber Dutch Lights", and No. 1722 "Fences", are of direct interest to farmers and horticulturists, the rest, though primarily applicable to general building work, being equally of use when preparing specifications for farms and horticultural holdings.

The 1952 Yearbook contains a complete list of, and an index to, the total of 1850 Standard Specifications now in print, and more are being drafted continually.

It is sometimes said that the existence of British Standards tends to make the specification writer lazy, because instead of quoting a standard in full he merely refers to its number, thereby throwing more bookwork on to the reader, especially the builder preparing a tender. Be that as it may, the fact remains that British Standards contain a wealth of material that can be used word for word by the specification writer.

N.K.G.

Fodder Beet (Mim. Pub. No. 1/1952). P. J. BOYLE. Commonwealth Bureau of Pastures and Field Crops. 5s.

The wide interest in fodder beet in Great Britain today has emphasized our lack of knowledge of Continental work with this crop. Here is a comprehensive review of research work and practice in Denmark, Sweden, Germany, the Netherlands, Belgium and France, together with such information as is available so far from British sources. Mr. Boyle has written and quoted at considerable length on all aspects of the crop, its origin, classification and nomenclature, history, varieties, cultivation, seed production, breeding and feeding value.

The review is compiled primarily for those interested in the technical aspects of the crop. Farmers will not find very much of direct value to them, but points of concern to breeders, nutrition experts, husbandry advisers and seedsmen are dealt with at length. It should be emphasized that much of the technical matter referred to is not directly applicable in this country, but it is of no less value for that. Seedsmen will be particularly interested in the very full list and description of varieties emanating from the various countries. It is to be hoped that this will not encourage an increase in the varieties imported into this country ; there are too many already, most of them with names too difficult to pronounce.

The publication covers 78 mimeographed foolscap sheets, and for 5s. is good value. Mr. Boyle may perhaps have erred on the side of too many tables and figures, but this is not a serious criticism in this type of review. One presumes that some of the statements of fact are based directly on the literature reviewed since they read, occasionally, as matters of opinion. A review should clearly and ostensibly be such—a condensation of the important conclusions of published literature.

This review of Fodder Beet is a valuable contribution to our understanding of a new and potentially valuable crop for livestock feeding, especially for pigs, in Great Britain.

C.V.D.

Essays in Leicestershire History. W. G. HOSKINS. Liverpool University Press. 20s.

Archaeology is all too often regarded as a dull subject, more suited to the scholar than to the man of affairs, but in the hands of a skilled writer it can be a source of endless interest to all.

Dr. Hoskins is recognized as an authority on the Midland counties, and whether he is giving expert directions on how to discover the sites of former communities or discussing the daily lives of those who lived and farmed in Leicestershire four centuries ago, he shows himself to be just such a writer—painting word pictures of the little things that go to make up life in any century. From those who know this Midland county well today his *Essays* will receive a warm welcome.

His description of the way of life of Richard Danne, a Leicestershire farmer who died in April, 1599, is memorable. Danne and his fellow farmers were no great believers in the creature comforts ; indeed the total value of their crudely-made household furniture was often far short of the value of the fuel in the wood-yard at the back of their simple homes.

It is widely believed that before the growing of roots it was usual to kill off a large proportion of livestock at the beginning of each winter. Questioning this view, as an exaggeration, Dr. Hoskins points out that it was the tithing custom in many Leicestershire parishes to base the tithe of sheep and wool on the number of sheep " going, feeding and couchinge " within the parish on New Year's Day. Furthermore, the grazing of sheep and cattle on winter wheat in late winter and early spring was common practice, even in the sixteenth century.

This book contains many interesting sidelights of this nature on the farming practice of four centuries ago, and will unquestionably appeal to the well-read farmer.

J. W.

The Land of Britain. LAURENCE EASTERBROOK. News Chronicle. 1s. 6d.

In the final analysis the life-blood of a country is its soil ; dissipate it, and the result is economic anaemia. It has taken the straitening circumstances of two world wars to impress this fundamental fact upon us, but today the man-in-the-street is at least beginning to recognize the importance of a balance between factory and farm ; the industrial "honeymoon" is clearly over. Farming makes news when food supplies are in jeopardy, and anything which promotes the common understanding of the conditions of nature and economics with which the farmer has to come to terms is a signal service.

Of such is this excellent forty-page, illustrated booklet in the *News Chronicle* series " Background to the News", written by Laurence Easterbrook, with all his customary skill, application of wide experience and deep concern for the welfare of the land. He uncovers sufficient of the past to show both the glories and the vicissitudes through which British agriculture has passed : the fat years and the lean, the alternating folly and wisdom which characterizes the nature of man, in this sphere as in others. He shows, too, something of that spirit of farming resurgence which, evoked in 1939, still pervades the country today.

Mr. Easterbrook has no myopic view of British agriculture against a purely national background, but sees it in focused perspective against world conditions. It is the *world* pattern that has altered. " We stand", he says, " as most of us now realize, at the beginning of a new epoch". More food from our own soil is not thus the expediency of the moment, and the ordinary man in his ordinary home, with his ordinary morning newspaper, cannot, with this booklet before him, fail to comprehend the full significance of those items of farming news which once seldom qualified for his attention.

S.R.O'H.

Farm Valuations (Young Farmers' Club Booklet No. 25). D. H. CHAPMAN. Evans Bros. 2s.

At the first approach, agricultural valuations sound a depressing subject, a necessary part of a tenant-farmer's life rather than a source of profit or pleasure. The phrase conjures up painful pictures of paragraph (c) of sub-section 7 of the Second Schedule of some omnipotent document known, with such finality, as *The* Act. Besides, valuations include costings, and while few would deny the importance of figures, fewer still find them an attractive medium in which to work. Yet in practice, there are not many men in such close and intimate contact with the technical and financial realities of the farming industry as the valuer, and there is a good deal of truth in the saying which one sometimes hears, " if you want to know what is happening in farming, ask a valuer". Indeed, much can be learnt not merely from particular valuations, but also from cultivating the professional habits of the valuer, in particular his powers of observation and assessment.

In this latest booklet of the Young Farmers' Club series, Mr. Chapman deals in brisk, practical, and amusing fashion with valuations as they affect the farmer. The material is inevitably a trifle hackneyed, for the subject, though in a constant state of development, is old and familiar, but the style and presentation, including the illustrations, are delightful. He sketches the origins of the agricultural valuation, its theory, its principles, and the legal framework which now controls it, and he finally accompanies two valuers as they walk round an imaginary, but very realistic, farm and settle the various points of tenant-right, improvements, dilapidations etc., arising. The book concludes with a chapter on annual stock-takings, and a short book list which surprisingly fails to include that most instructive booklet published by H.M. Stationery Office, *The Rights and Obligations of Landlords, Tenants and Owner-occupiers of Agricultural Land.*

If Mr. Chapman would turn his cheerful and informed attention to the writing of text-books, we should certainly have happier examinees, and probably happier examiners as well.

N.H.

The Artificial Illumination of Seedlings (John Innes Leaflet No. 11). Oliver and Boyd. 9d.

This leaflet will be welcomed by glasshouse growers as the practical outcome of experimental work at the John Innes Horticultural Institution on the use of artificial light to make good the lack of natural light for winter-raised seedlings.

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R.T.P.

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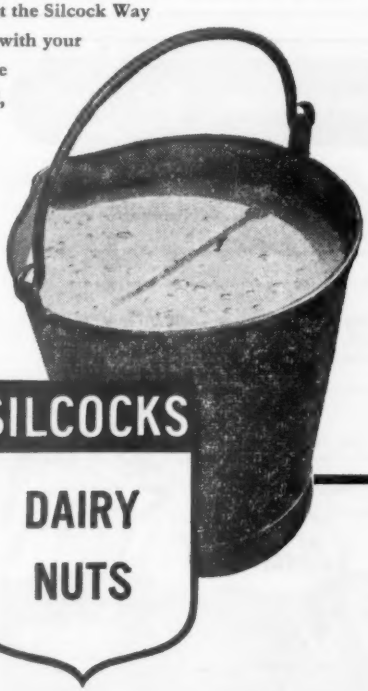

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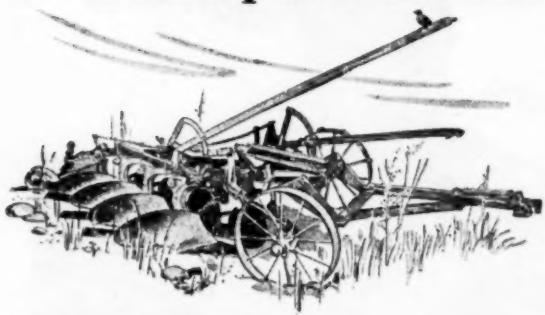

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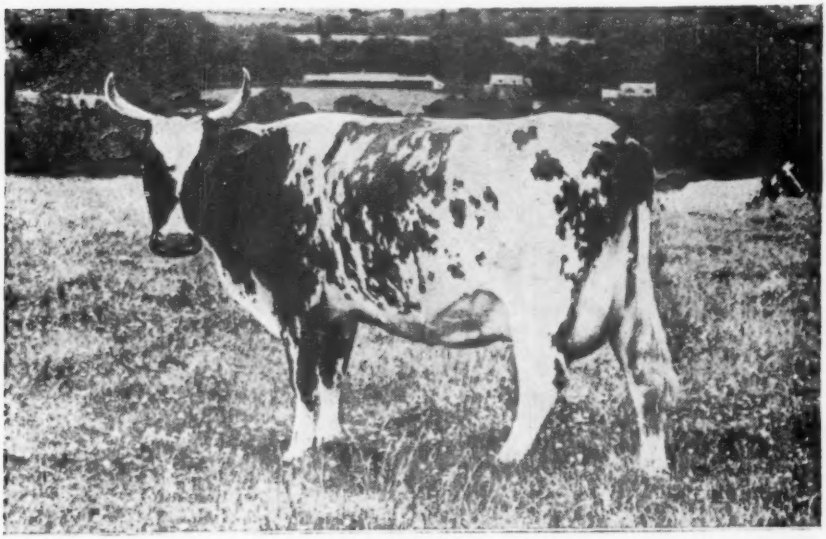

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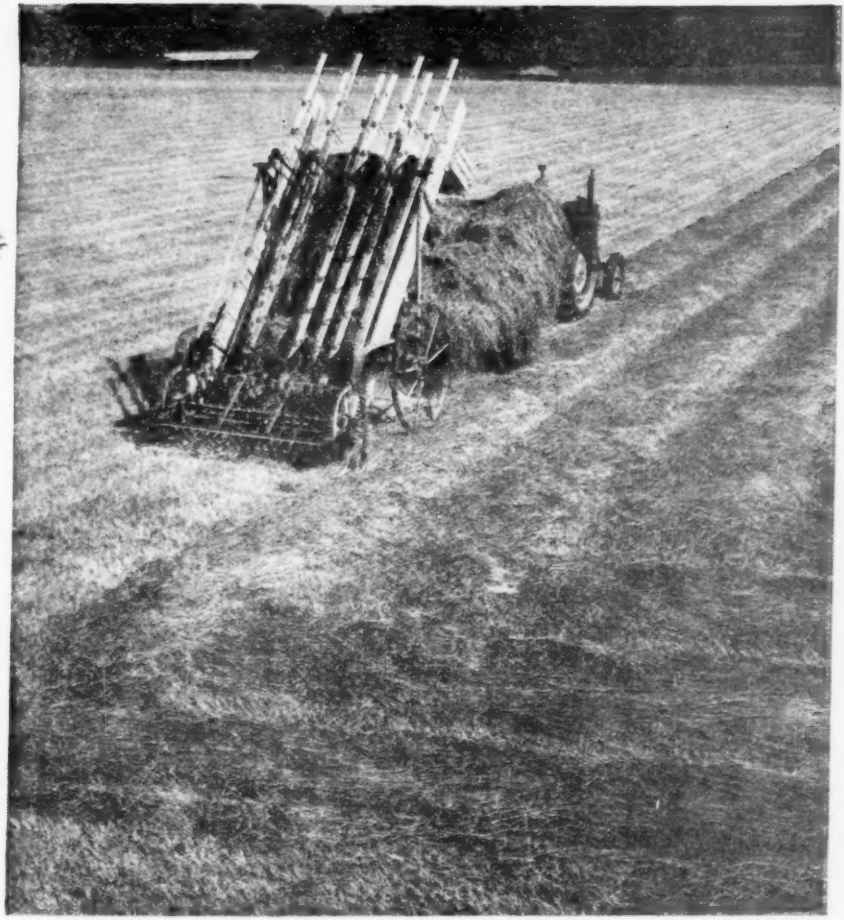

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